Test Equipment Maintenance Department
Location:- D1
ID 0378

INSTRUCTION MANUAL

MODEL 734

PULSE/FUNCTION GENERATOR

EXACT
electronics, inc.

ML5748

SYST ENG

INSTRUCTION MANUAL

MODEL 734

PULSE/FUNCTION GENERATOR

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EXACT electronics, inc.

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IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.
2. Check fuse and power supply voltages.
3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

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SECTION 1

SPECIFICATIONS

AND

VERIFICATION OF SPECIFICATIONS PROCEDURE

WAVEFORMS

Sine, triangle, square, pulse, $\overline{\text{pulse}}$, TTL, $\overline{\text{TTL}}$, ECL, $\overline{\text{ECL}}$, SYNC, DELAYED SYNC

FREQUENCY/PERIOD REPETITION RATE RANGE

0.0001 Hz/10000 sec to 30 MHz/33 nsec in 13 overlapping ranges.
Ten turn type resolution.
1000:1 vernier range in continuous dial mode.

FREQUENCY/PERIOD ACCURACY

±(1% of setting plus 1% of full scale) 0.01 Hz/100 sec to 1 MHz/1 μ sec.
±(2% of setting plus 2% of full scale) 1MHz/1 μ sec range and 0.0001 Hz/1000 sec to 0.01 Hz/100 sec.
±(4% of full scale) 3MHz/330 nsec range.

FREQUENCY/PERIOD STABILITY

Within 0.05% of setting for 10 minutes.
Within 0.25% of setting for 24 hours.

MAIN OUTPUT

50 ohms output impedance.
30 V P-P open circuit.
15 V P-P into 50 ohms.

AMPLITUDE STABILITY

Within 0.05% of max. P-P amplitude for 10 minutes.
Within 0.25% of max. P-P amplitude for 24 hours.

ATTENUATOR

60 dB in 10 dB steps plus 20 dB variable.

SINEWAVE FREQUENCY RESPONSE

Within 0.1 dB to 100 KHz.
Within 2 dB to 30 MHz.

SINEWAVE DISTORTION

<0.5% 0.0001 Hz to 100 KHz
No harmonics less than 30 dB down 100 KHz to 30 MHz.

SQUAREWAVE AND PULSES

Rise and fall times less than 10 nsec.
Aberrations less than 5% of maximum P-P amplitude

SYMMETRY (time)

Within ±(1% plus 2 nsec)

TRIANGLE NONLINEARITY

Within 1% of best straight line to 100 KHz.

GATE AND TRIGGER MODES

DC coupled.
Input impedance: approximately 1K.
Signal requirements: 500 mV or manual for turn on.
Variable sensitivity to +15 V.

VCF INPUT

0 to 5 V input for 1000:1 frequency control.

DC OFFSET

Switchable and variable.
±7.5 V into an open circuit.
±3.75 V into 50 ohms.
Not affected by attenuator settings.

TTL OUTPUTS

Approximately 3 V Peak.
Will drive 50 ohm load.
Normal and complement outputs available simultaneously.

ECL OUTPUTS

Approximately -0.9 V to -1.7 V typical.
Will drive 50 ohms terminated to -2 Volts.
Normal and complement outputs available simultaneously.

DUTY FACTOR

Greater than 50%.

DOUBLE PULSE

Spacing set by delay control.
Minimum spacing between double pulse leading edges is equivalent to at least 50 MHZ.

DELAY

7 position rotary switch and 10:1 vernier.
20 nsec to 10 msec in 6 overlapping ranges.
(7th position provided for custom range installed by user).

WIDTH

8 position rotary switch and 10:1 vernier.
10 nsec to 10 msec in 6 overlapping ranges.
(7th position provided for custom range installed by user).
8th position provides a square wave mode.

POWER REQUIREMENTS

Input voltage: 115 VAC ±10% or 220 VAC ±10%, other voltages available.

PHYSICAL CHARACTERISTICS

Case dimensions: 43 cm wide by 13 cm high by 34.8 cm deep.
Overall dimensions: 43 cm wide by 14.5 cm high by 39 cm deep.
Top and bottom covers are easily removable, exposing all calibration and circuit board areas.

NOTE

Unless otherwise specified, specifications apply from 10% to maximum output voltage terminated into 50 ohms and do not apply at frequency multiplier settings less than 1.0. Specifications are valid at 25°C ±5°C after a 30 minute warmup and with specified line voltage applied. Stability specifications are for constant line voltage and constant temperature.

Specifications are subject to change without notice.

It is recommended that the instrument be operated with covers in place for a period of 1 hr. before verification of specifications.

The following test equipment or suitable equivalents of known accuracy are required for complete specification validation for the Model 734 PULSE FUNCTION GENERATOR.

Oscilloscope, DC to 100MHz
Differential Input with 5mV/cm sensitivity
Tektronix 7704 with 7A13 Plug-in or equivalent
Counter-Timer, 30 MHz to 10,000 seconds
Racal-Dana 8010B or equivalent
DVM, 0.01% accuracy with 1,000 meg ohm floating input
Racal-Dana 4600 or equivalent
Harmonic Distortion Analyzer, less than .1% residual distortion
H-P 333A or equivalent
Spectrum Analyzer, 1KHz to 110MHz
Hewlett-Packard 141T, 8553B, 8552B or equivalent

Preset all the front panel controls as follows:

MULTIPLIER - 10
HZ/SEC 100 HZ
FUNCTION - square
AMPLITUDE - mid range
D.C. OFFSET - deactivated
ATTENUATOR - All sections deactivated
RUN - activated
START LEVEL - mid range
GATE - deactivated
SINGLE - deactivated
TRIGGER LEVEL - mid range
PULSE DELAY -10 μ SEC
DELAY VERNIER - FULL CW
PULSE WIDTH - 10 μ SEC
WIDTH VERNIER - FULL CW
DELAY DOUBLE - NORMAL

FREQUENCY ACCURACY: To measure the frequency accurately all frequency measurements below 1 kilohertz are expressed in time and all above in freq. With the counter connected to main output: terminated in 50Ω, measure the following:

Mult.	HZ/SEC	Actual Setting	Accuracy	Generator should be within
10.0 X	.001	.01Hz	±(2% of setting + 2% of Range)	104 Sec. to 96 Sec.
1.0 X	.001	.001Hz	"	1282 " to 820 "
10.0 X	.01	.1Hz	±(1% of setting + 1% of Range)	10.2 " to 9.8 "
1.0 X	.01	.01Hz	"	112 " to 90 "
10.0 X	.1	1.0Hz	"	1.01 " to .99 "
1.0 X	.1	.10Hz	"	11.2 " to 9.00"
10.0 X	1	10Hz	"	.102 " to .098"
1.0 X	1	1.0Hz	"	1.11 " to .890"
10.0 X	10	100Hz	"	10.2 ms to 9.80 ms
1.0 X	10	10Hz	"	112 ms to 90.0 ms
10.0 X	100	1KHz	"	1.02 ms to .980 ms
1.0 X	100	100Hz	"	11.2 ms to 9.00 ms
10.0 X	1K	10KHz	"	9.80 KHz to 10.2 KHz
1.0 X	1K	1KHz	"	.890 KHz to 1.11 KHz
10.0 X	10K	100KHz	"	98.0 KHz to 102 KHz
1.0 X	10K	10KHz	"	8.90 KHz to 11.1 KHz
10.0 X	100K	1.0MHz	"	.980 MHz to 1.02 MHz
1.0 X	100K	100KHz	"	89.0 KHz to 111 KHz
10.0 X	1M	10MHz	±(2% of Range + 2% of setting)	9.60 MHz to 10.4 MHz
1.0 X	1M	1MHz	"	.780 MHz to 1.22 MHz
10.0 X	.30M	30MHz	±(4% of Range)	28.8 MHz to 31.2 MHz
1.0 X	.30M	3MHz	"	1.8 MHz to 4.2 MHz

SINE DISTORTION: Return the Function Selector to Sine Wave and also check to see that generator frequency is set for 1 kilohertz. Amplitude Control should be set for mid range.

1. Connect Distortion Analyzer to the Output Connector terminated into 50Ω. Measure the sine distortion of less than .5%. (typically .2%).

2. Set the FREQUENCY to 100KHz. Measure Sine distortion of less than .5%.

3. Set Range to 1MHz. Connect the Spectrum Analyzer to main output jack and measure the harmonic content. Observe no harmonics less than 30 db down from fundamental.

4. Check Harmonic Content on 10MHz and 30MHz Range. Observe no harmonics less than 30 db down from fundamental.

SINE FREQUENCY RESPONSE: Set the HZ/SEC to 1K and Multiplier to 10 and connect the oscilloscope to the Output connector.

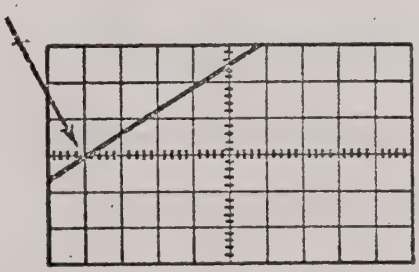
1. Observe sine wave amplitude.
2. Set HZ/SEC to 10K. Observe sine amplitude change of less than .db.
3. Set HZ/SEC to 3 MHz. Observe sine amplitude change less than 2db.

SQUARE WAVEFORM: Set Function Switch to Square. Set Amplitude Control for an output voltage of 15V peak to peak or less into 50 Ω.

1. Observe the rise and fall time to be less than 10 ns.
2. Observe that the overshoot and ringing are less than 5% of maximum peak to peak amplitude.

TRIANGLE LINEARITY: Set HZ/SEC Switch to 100 HZ, Multiplier to 10. Set the Function Selector to Triangle. Monitor the Output Connector with the oscilloscope.

1. Adjust the oscilloscope to obtain 1/2 cycle of the triangular waveform across the full horizontal grid on the oscilloscope CRT.
2. Reset the Differential Plug-in to a sensitivity of 20 millivolts per centimeter.
3. Adjust the comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below.



TRIANGLE LINEARITY: (Continued)

4. Record reference voltage using the DVM accurate to 1 millivolt.

5. Adjust the comparison voltage until slope of triangle intersects next major horizontal grid mark.

6. Record accurately the new reference voltage.

7. Repeat to obtain as many points as desired.

8. Calculate linearity and observe linearity is within specifications.

9. Beware of oscilloscope inadequacies above 10KHz.

FREQUENCY STABILITY: Connect Frequency Counter to main output terminated into 50Ω. Measure frequency accurately. Note the frequency reading. Wait 10 minutes. Measure frequency again and note that frequency change should be less than .05%. Wait 24 hrs. Measure frequency again and note reading remains within .25%.

AMPLITUDE STABILITY: Set amplitude control to maximum. Set DC Offset to Off. Function to Triangle. Connect output of generator to oscilloscope and measure the output, both positive and negative peaks with a 20 millivolt per centimeter sensitivity on the oscilloscope. Measure accurately and record the value of the positive and negative peaks that the triangle produced at the output. Wait 10 minutes and measure positive and negative peaks again and observe the amplitude changes less than 15 millivolts. Wait 24 hrs., measure the positive and negative peaks again and observe the amplitude change is less than 75 millivolts. Note that when measuring the amplitude using the peaks the maximum peak to peak value is the addition of the two peak values.

TIME SYMMETRY: Connect the counter timer to the Sync Output Connector on the front panel. Set the HZ/SEC to 1K and set the MULTIPLIER to 10. Set the Counter Timer to read time interval A to B and B to A. Observe the time symmetry error is less than 1%.

1. Set HZ/SEC switch to 100. Observe time symmetry error less than 1%.

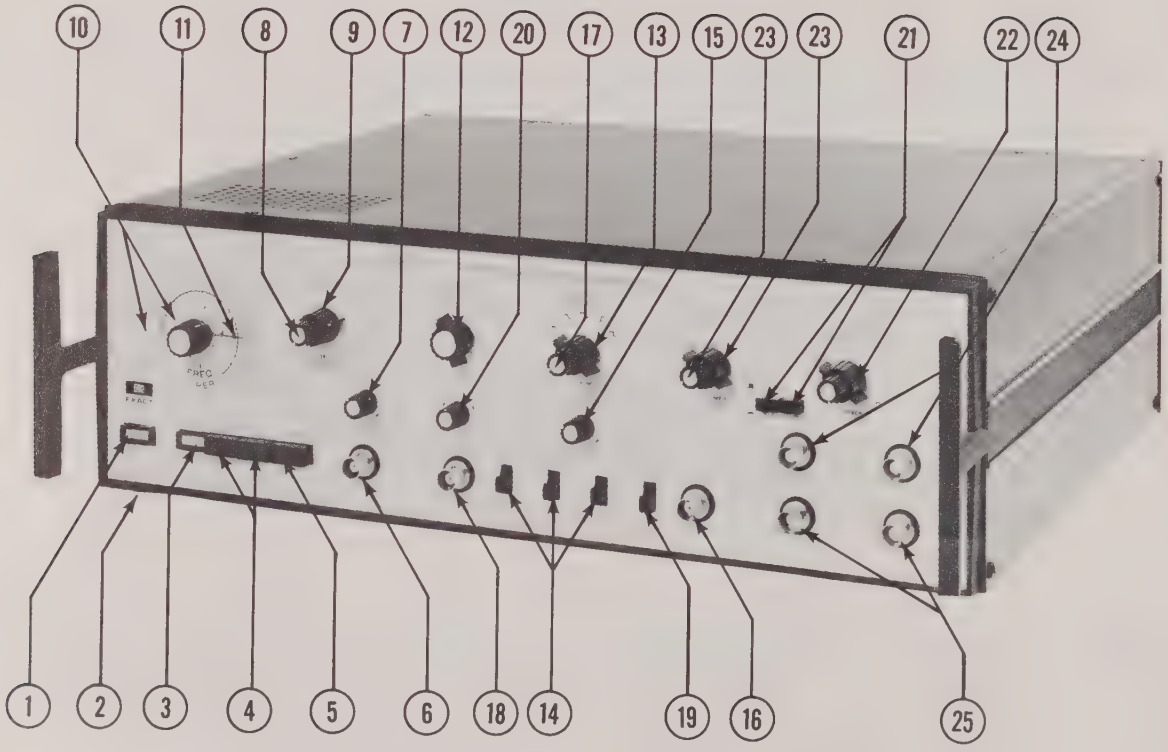
2. Set HZ/SEC to 10. Observe time symmetry error less than 1%.

3. Set HZ/SEC to 1. Observe time symmetry error less than 1%.

4. Set HZ/SEC to 0.1. Observe time symmetry error less than 1%.

SECTION 2

OPERATING INSTRUCTIONS



FRONT PANEL FAMILIARITY
MODEL 734

FRONT AND REAR PANEL FAMILIARITY

1. POWER SWITCH - Applies power to generator.

2. BAIL - Allows tilting the instrument for bench operation.

3. RUN - Causes Main generator to free run.

4. TRIG MODE - Two pushbuttons select SINGLE (triggered) or GATE (burst) modes.

   a. In the SINGLE mode, one complete cycle is produced for each trigger command.

   b. In the GATE mode, cycles are produced until the trigger command is removed. The last cycle is completed.

5. MANUAL - Pushbutton allows manual triggering and gating.

6. EXT TRIG - BNC connector accepts signals for externally triggering or gating the Main generator. DC coupled with an input impedance of 1 K Ohms and a sensitivity of +500 mV.

7. TRIG LEVEL - Adjusts trigger sensitivity from +500 mV to +15V.

8. START LEVEL - Adjusts start phase of Main generator waveforms over a $\pm 90^{\circ}$ range when the RUN button is disengaged. Allows user to produce haversine and $Sine^2$ waveforms.

9. HZ/SEC - Selects the desired Main generator frequency/period RANGE.

10. MULTIPLIER DIALS - Can be operated in three different modes with LED's indicating the mode.

    a. Dual Dial Mode: The inner dial sets the Main generator frequency from 1 to 10 times the HZ/SEC SWITCH setting in ten steps. The outer dial then allows continuous settings between the inner dial settings, providing 10-turn type resolution and 10% overrange.

    b. Continuous Dial Mode: With the inner dial set to the FREQ position, the outer dial linearly sets the Main generator frequency from 0.01 to 10 times the HZ/SEC Switch setting. An LED indicates the frequency setting on the frequency scale.

    c. PERIOD MODE: With the inner dial set to the PER position, the outer dial sets the Main generator period from 0.10 to 100 times the HZ/SEC switch setting. An LED indicates the period setting on the blue scale.

11. LED'S - Indicate the selected MULTIPLIER dial mode and index the dial settings.

12. MODE - Selects the waveform supplied at the OUTPUT (16). DC is controlled by the OFFSET control (20) $\overline{\text{PULSE}}$ and PULSE are controlled by the pulse controls (21, 22, and 23); and FUNCTION is the Waveform selected by FUNCTION (13).

13. FUNCTION - Selects the output waveform desired when FUNCTION is selected by the MODE switch (12).

14. ATTENUATOR - Three slide switches provide 60dB of output waveform attenuation in 10dB steps. Does not affect OFFSET (20).

15. AMPLITUDE - Allows 20 dB continuously variable voltage at the output connector. In combination with the ATTENUATOR (14), provides a total attenuation of 80 dB.

16. OUTPUT - Main output BNC connector outputs the waveform selected by the FUNCTION (13) and MODE (12) switches. 50 ohm output impedance. 30 V P-P maximum into an open circuit.

17. SYNC SELECTOR SWITCH - Selects sync output from either delay generator or main generator.

18. SYNC OUT - BNC connector provides a TTL compatible squarewave at the start of either Main or Delay Generator depending upon the position of SYNC SELECTOR SWITCH (17). Provides approximately +3V peak output.

19. OFFSET SWITCH - Enables DC OFFSET CONTROL (20).

20. DC OFFSET CONTROL - Provides up to $\pm$ 7.5 volts of variable DC offset at the OUTPUT connector.

21. NORMAL/DELAY/DOUBLE - Selects normal, double, or delayed pulses.

22. PULSE WIDTH - The outer knob selects the pulse width range from 10 nsec to 1 msec and the inner knob continously adjusts the pulse width from 1 to 10 times the range. A 7th position of the outer knob selects a custom range you add by installing a capacitor. The 8th position is a squarewave mode (pulse width equal to 1/2 the period as set by the MULTIPLIER (10) and HZ/SEC (9) in squarewave mode).

23. PULSE DELAY - The outer knob selects the delay range from 10 nsec to 1 msec and the inner knob continously adjusts the delay from 1 to 10 times the range. A 7th position of the outer knob selects a custom range you add by installing a capacitor. The PULSE DELAY also sets the time delay between the pulse leading edges when in the double pulse mode.

24. TTL OUTPUTS - Two BNC connectors supply TTL outputs. The TTL output supplies normal pulse outputs, while the $\overline{\text{TTL}}$ output supplies complementary pulse output. Both of these outputs are TTL compatible and will drive 50 ohms. These outputs are always controlled by the PULSE DELAY, PULSE WIDTH, and NORMAL/DELAY/DOUBLE regardless of the MODE (12) selected.

25. ECL OUTPUTS - Two BNC connectors supply ECL outputs. The ECL output supplies normal pulse outputs while the $\overline{\text{ECL}}$ output supplies complementary pulse outputs. Both of these outputs are ECL compatible and will drive 50 ohms terminated to -2V. This output is always controlled by the PULSE DELAY, PULSE WIDTH, and NORMAL/DELAY/DOUBLE regardless of the MODE (12) selected.

26. V:f OUTPUT - A rear panel BNC providing a voltage proportional to the frequency. The output is approximately 0 to 5V for a 1000:1 frequency change.

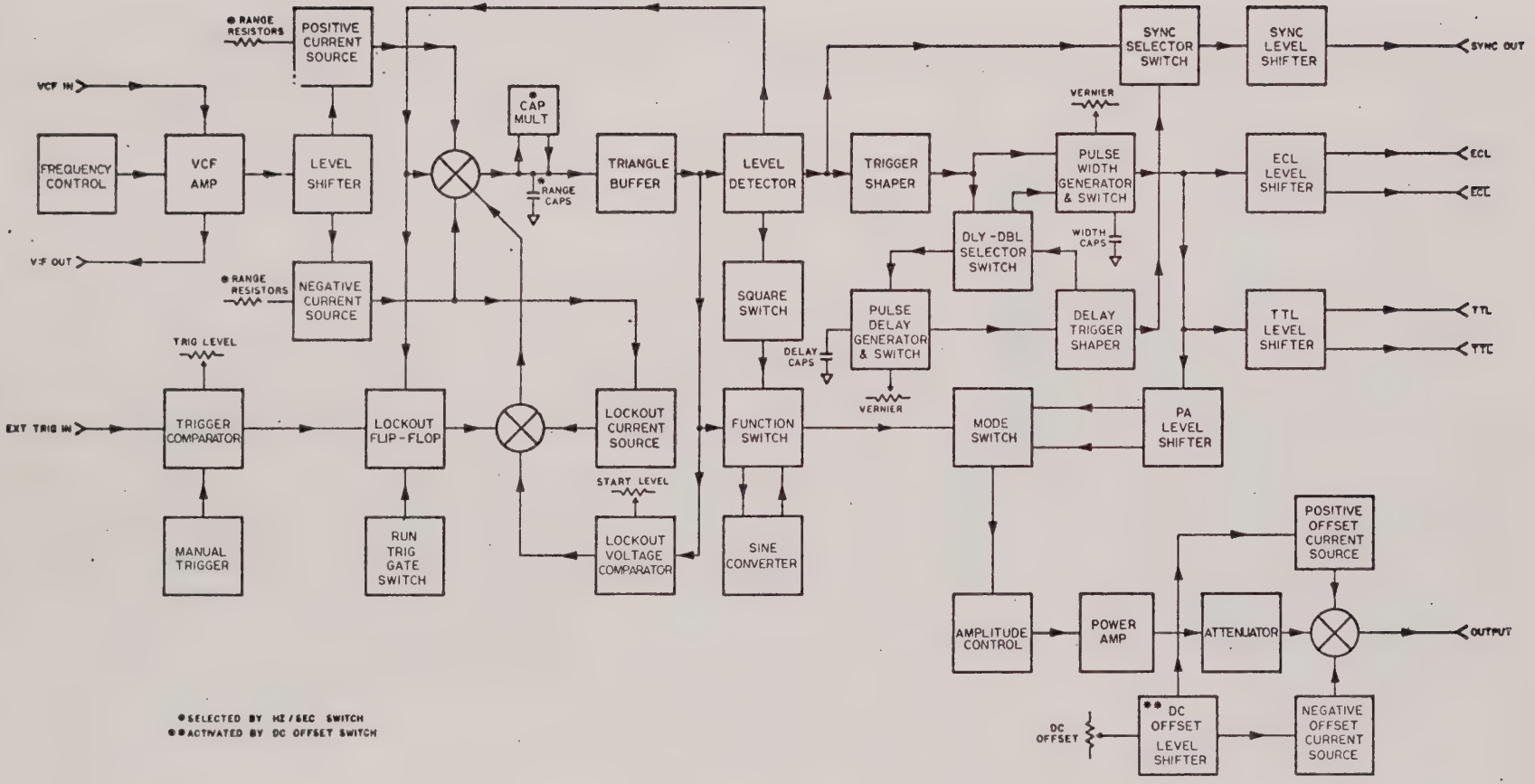
27. VCF INPUT - Rear panel BNC connector allows external frequency control, frequency modulation, or frequency sweeping of the Main generator. A 0 to 5V input will vary the frequency 1000:1.

28. CHASSIS GROUND - Connected to the instrument case and to the ground pin of the power plug.

29. CIRCUIT COMMON - Allows user to connect the generator circuit common to other than CHASSIS GROUND (to eliminate ground loops, etc.) The maximum allowable voltage between CIRCUIT COMMON and CHASSIS GROUND is 50V. (0.05 μfd shunt capacitance). This provision is made ONLY so the user can eliminate ground loops. Be sure the circuit is connected to ground through the connecting cables.

SECTION 3.

CIRCUIT DESCRIPTION



734 BLOCK DIAGRAM

MAIN GENERATOR CIRCUITS

The main generator is a triangle generator loop. A precision voltage source supplied by a Kelvin-Varley voltage divider, (the frequency multiplier control on the front panel) is summed at a voltage controlled frequency amplifier with the voltage controlled frequency (VCF) input for external frequency control. The output of the VCF amp is routed to the level shifters to generate the voltage levels necessary to drive the positive and negative current sources. The VCF amp also drives the linear voltage proportional to frequency buffer amp whose output is connected to the lin V:F BNC located on the rear panel.

The positive and negative current sources are voltage to current converters whose current output is determined by the voltage applied to them by the level shifters and current range resistors. The current range resistors and capacitor are selected with the frequency range switch. The voltage applied to the current sources is determined by the setting of the frequency multiplier control. Both these controls are located on the front panel. VCF IN will modify this voltage allowing external frequency control or sweeping. The HZ/SEC sets frequency range.

The negative current source also drives a lock-out current source which is used in the TRIG and GATE modes of the main generator to be discussed later. This current source tracks the negative current source and also has current range resistors which are selected with the HZ/SEC switch.

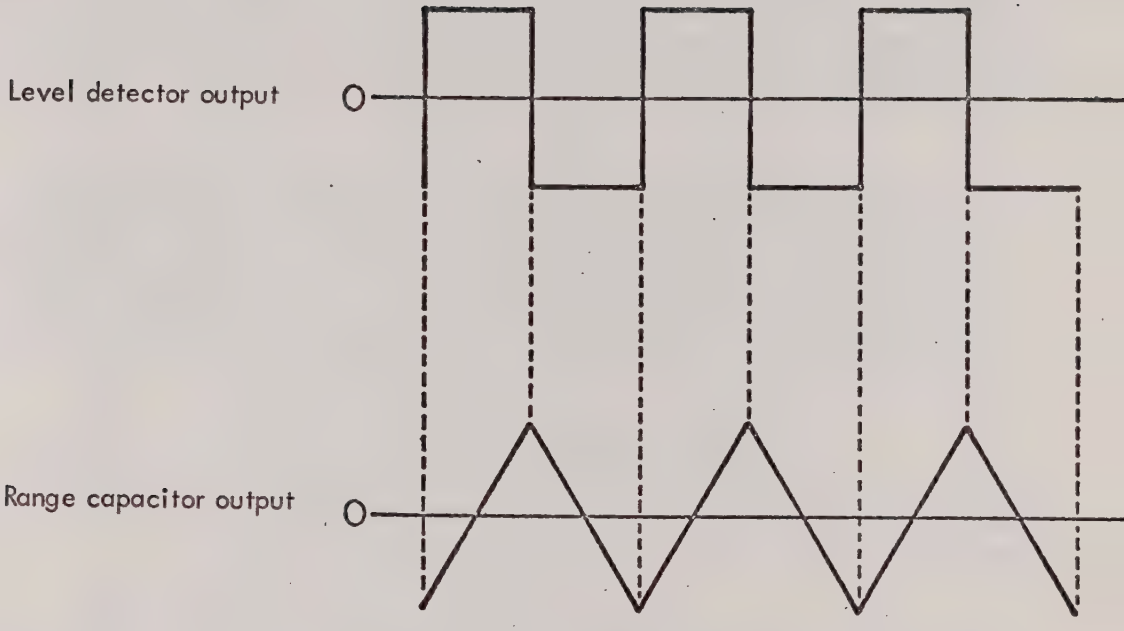
On the lower frequency ranges, a capacitance multiplier is switched into the circuit where the range capacitor would normally be. The cap multiplier has the capability of making a small capacitor function as if it's value were much greater than it really is. This allows realistic values of timing capacitors to be used on the very low frequency ranges.

The current source outputs are switched into the selected timing capacitor selected by the frequency range switch. This occurs via a diode switching bridge controlled by the output of the level detector, a bi-stable switch with fixed switching levels. The triangle buffer isolates the Range capacitor from the level detector.

The circuits just discussed comprise the basic generator loop for triangle and square wave generation. Assume that the level detector output is in the state that allows the positive current source to supply current to the timing capacitor. The capacitor will start charging linearly. The rate of charge or slope will depend on:

1. The size of the capacitor
2. The current supplied by the positive current source.

When the capacitor reaches the preset voltage of the level detector, the output of the level detector switches and the negative current source starts supplying current to the range capacitor. Since the negative current source is a mirror of the positive current source, the charging rate is the same but opposite in polarity. The range capacitor charges to the negative preset voltage of the level detector and the level detector switches again. The positive current source once again supplies current to the range capacitor. The following figure shows the result.



The action is continuous, and the result is a triangle and square wave of the same frequency available at the outputs of the triangle buffer and level detector respectively. The frequency is determined by the selected range capacitors and resistors and the current supplied by the sources. This current can be changed by the voltage applied to the current sources, therefore, the front panel Frequency Multiplier and VCF input determine the frequency within the selected Frequency Range.

Both triangle and square waveforms are delivered to the FUNCTION switch which selects either triangle on square wave or supplies the triangle to the SINE CONVERTOR in the SINE position. The SINE CONVERTOR uses shaping and amplifing circuits to convert the triangle to a sinusoidal waveform of equal amplitude to the triangle. The square wave is attenuated to half amplitude and offset all positive with respect to ground in the positive pulse position of the FUNCTION switch and all negative in the negative pulse position. This allows an additional pulse mode in the SINGLE or GATE modes of the main generator. The pulse width is equal to one half the selected period and the repitition rate is equal to the external clock applied to the TRIG IN connector. The pulses can be activated by depressing the MAN button as well. The selected waveform is delivered to the AMPLITUDE control on the front panel through the MODE switch. The AMPLITUDE control provides a 20 dB

continuously variable control of the amplitude of the selected waveform. The AMPLITUDE control delivers the selected waveform to the power amplifier. The signal is amplified to a maximum of 30V P-P by the power amplifier. Additive, individually front panel switched attenuators of 10, 20, and 30 dB provide a total of 60 dB increments. Post attenuator D.C. offset is provided by positive and negative current sources controlled by a front panel D.C. OFFSET adjustment that controls D.C. OFFSET level shifting circuitry. The output of the level shifter controls the current that is summed after the output attenuators. This allows ±7.5V of D.C. offset that is unaffected by attenuator settings.

The square wave from the level detector is also delivered to the SYNC SELECTOR switch on the front panel. This switch selects either the square wave from the level detector or the DELAYED SYNC PULSE from the DELAY TRIGGER SHAPER in the pulse circuitry. The output of the SYNC SELECTOR switch is level shifted and available at the SYNC OUT BNC on the front panel.

The MODE switch selects the output of the function switch in the MAIN GENERATOR, or selects the positive or negative pulse output from the P.A. LEVEL SHIFTER from the pulse circuits in the PULSE mode positions. The DC position of the MODE switch provides a DC output and the DC level is controlled by the DC offset control.

When the TRIG pushbutton is engaged, the lock out current source is summed in the RANGE capacitor with the current from the + current source, preventing the charge on the RANGE capacitor from changing. The LOCK OUT comparator compares the output of the triangle buffer to the level set by the START LEVEL CONTROL which determines the level of the waveform at which lock out occurs. When an External Trigger signal overcomes the level set by the trigger level control, the LOCK OUT control flip flop switches and diverts the current from the LOCK OUT current source allowing the generator to start to run. The second transition of the level detector resets the LOCK OUT control flip flop, allowing the LOCK OUT current source to lock the generator out again when it reaches the level set by the START LEVEL phase control on the front panel. One complete cycle is generated for each External input trigger signal, the starting and stopping level or phase controlled by the START LEVEL control.

When the GATE pushbutton is engaged the operation is the same, except the LOCK OUT control flip flop reset is inhibited as long as an external gate signal is applied. The LOCK OUT flip flop resets on the proper transition of the level detector, after the gate signal is removed, which always guarantees an integer number of cycles.

PULSE CIRCUITS

The PULSE GENERATOR is not a freerunning generator but is an extremely fast switching and pulse shaping circuit thar is triggered into operation by the MAIN GENERATOR. Therefore, the pulse rep-rate and period is determined by the settings of the MAIN GENERATOR. The MAIN GENERATORS HZ/SEC AND FREQUENCY MULTIPLIER controls are calibrated in PERIOD ás well as FREQUENCY for this purpose.

PULSE CIRCUITS (Continued)

There are two basic circuits that comprise the PULSE GEN, the DELAY timer and the WIDTH timer which are electrically identical. These circuits are active as long as the MAIN GEN is running even though the MODE switch is not selecting either pulse mode.

A negative transition on the trigger pulse originating in the MAIN GEN will cause the WIDTH timer to start its time cycle and send a positive transition to several LEVEL SHIFTERS, which will be described later. When the WIDTH timer completes its time cycle, it is automatically reset for another cycle and simultaneously sends a negative transition to the LEVEL SHIFTERS. The time duration between the positive and negative transitions is set by the selection of the timing capacitor and the setting of the 10:1 vernier control. These transitions comprise the PULSE.

The DELAY timer works similarily to the WIDTH timer described above however, it is connected in a manner that gives different results at the output. When the DELAYED pulse is selected, the trigger from the MAIN GEN is disconnected from the WIDTH timer and routed to the DELAY timer. The DELAY timer now triggers the WIDTH timer. A negative transition of the trigger from the MAIN GEN starts the DELAY timer. When the DELAY timer completes its time cycle, a negative transition is sent to the WIDTH timer and starts it timing. This is the beginning of the delayed PULSE. The delayed pulse ends when the WIDTH timer completes its time cycle, and both timers are reset and ready for another sequence.

A DOUBLE pulse mode is also available. In this mode the DELAY and WIDTH timers are both triggered simultaneously from the MAIN GEN. The WIDTH timer must be set to complete its time cycle first for this mode to operate properly. When the WIDTH timer completes its time cycle, the first pulse is completed. When the DELAY timer completes its time cycle it triggers the WIDTH timer again causing it to go through another cycle and reset. This finishes the second pulse of the DOUBLE pulse mode. The WIDTH RANGE and VERNIER control the width of both pulses. The DELAY RANGE and VERNIER controls the time interval between the first and second pulse.

The LEVEL SHIFTER PHASE SPLITTERS (LSPS) perform the same functions but to different voltage levels. The operating logic voltage levels of the WIDTH and DELAY circuits are shifted in "DC" level compared to conventional levels before being routed to the output BNC connectors and the output power amplifier. The single phase input is split into two signals 180 degrees apart. The ECL LSPS shifts the DC logic levels from a positive 5 volt supply system to a more conventional negative 5 volt supply. The TTL LSPS shifts the ECL levels to conventional TTL levels. The PA LSPS shifts the ECL levels to 1 volt peak and the amplitude is adjustable in this stage so the pulses can be precisely adjusted to match the amplitude of the FUNCTION GENERATOR wave forms.

POWER SUPPLY

The primary power for this instrument is supplied through the line cord to fuse F-1 which is selected for each voltage of operation. The primary is then applied through the main power switch S-1 to the transformer primary and line voltage switch S-2. The Line Voltage switch S-2 selects the method of connection for the primary taps so that a selection is available as to which line voltage the instrument will operate at. Transformer T-1 steps down the operating potentials of the input primary power so that the proper voltage is developed through the use of diodes D-4 through D-7 and filter capacitors C-3 and C-4. This full wave center tapped bridge rectifier provides both positive and negative operating potentials of sufficient magnitude to be regulated through the use of the plus and minus 15 volt regulators. Integrated circuit U-1 has self contained voltage reference and error amplifiers. The output of these error amplifiers are fed to series pass transistors Q-1 and Q-2 which enhance the current carrying capability of U-1. Resistors R-5 and R-7 are current sensing resistors that allow Q-1 and Q-2 to reduce the output voltage of the supply in the event the current reaches a predetermined value. The voltage feedback, necessary for the error amplifiers are derived through the use of potentiometers R-9 through R-11. The potentiometers R-9 and R-11 allow a vernier adjustment of the power supply voltages. Diodes D-8 and D-9 are used to prevent accidental application of reverse voltages to the regulator. Application of opposite polarity voltage would damage the integrated circuit. Capacitors C-7 and C-8 prevent the build up of transient voltage at the output of the supply under varying load conditions.

Diodes D-1 and D-2 in conjunction with R-1 and C-1 form a positive voltage supply. Regulation for this supply is performed with a three terminal voltage regulator U-1 (rear panel). This type of regulator has an integral valtage reference and current sensing device that are preset and not adjustable. Diode D-3 is used to prevent accidential application of negative voltage to U-1 (rear panel), which would damage the regulator. Capacitor C-2 is used to enhance the transient responce of the regulator under varing load conditions.

Diodes D-10 through D-13 and resistors R-12 and R-13 in conjunction with filter capacitors C-9 and C-10, provide both positive and negative operating potentials of sufficient magnitude to be regulated through the use of the two three terminal regulators U-2 (rear panel) and U-3 (rear panel). The operation of these two regulators is similar to U-1 (rear panel) described above. However, the common terminal is referenced to a variable voltage instead of ground. U-2 (power supply board) is the variable voltage source whose input is connected to voltage divider R-15m, R-16m and R-17m referenced between plus and minus 15 volts. Potentiometer R-16 allows the voltage division to be adjustable and U-2 (power supply board) boosts the current handling capability before being routed to U-2 (rear panel). The normally fixed regulated voltage of U-2 (rear panel) pin 2 is now adjustable. Diode D-14 is used to prevent accidental application of negative voltage to U-2 (rear panel) which would damage the regulator. Capacitor C-11 is used to enhance the transient response of the regulator under varying load conditions.

U-3 (rear panel), U-3 (power supply board) and associated circuitry functions exactly as described above for U-2 (rear panel) and U-2 (power supply board) except that the regulator U-3 (rear panel) is for a negative voltage supply. Diode D-15 is used to prevent accidental application of a positive voltage to U-3 (rear panel) which would damage the regulator. Capacitor C-12 is used to enhance the transient response of the regulator under varying load conditions.

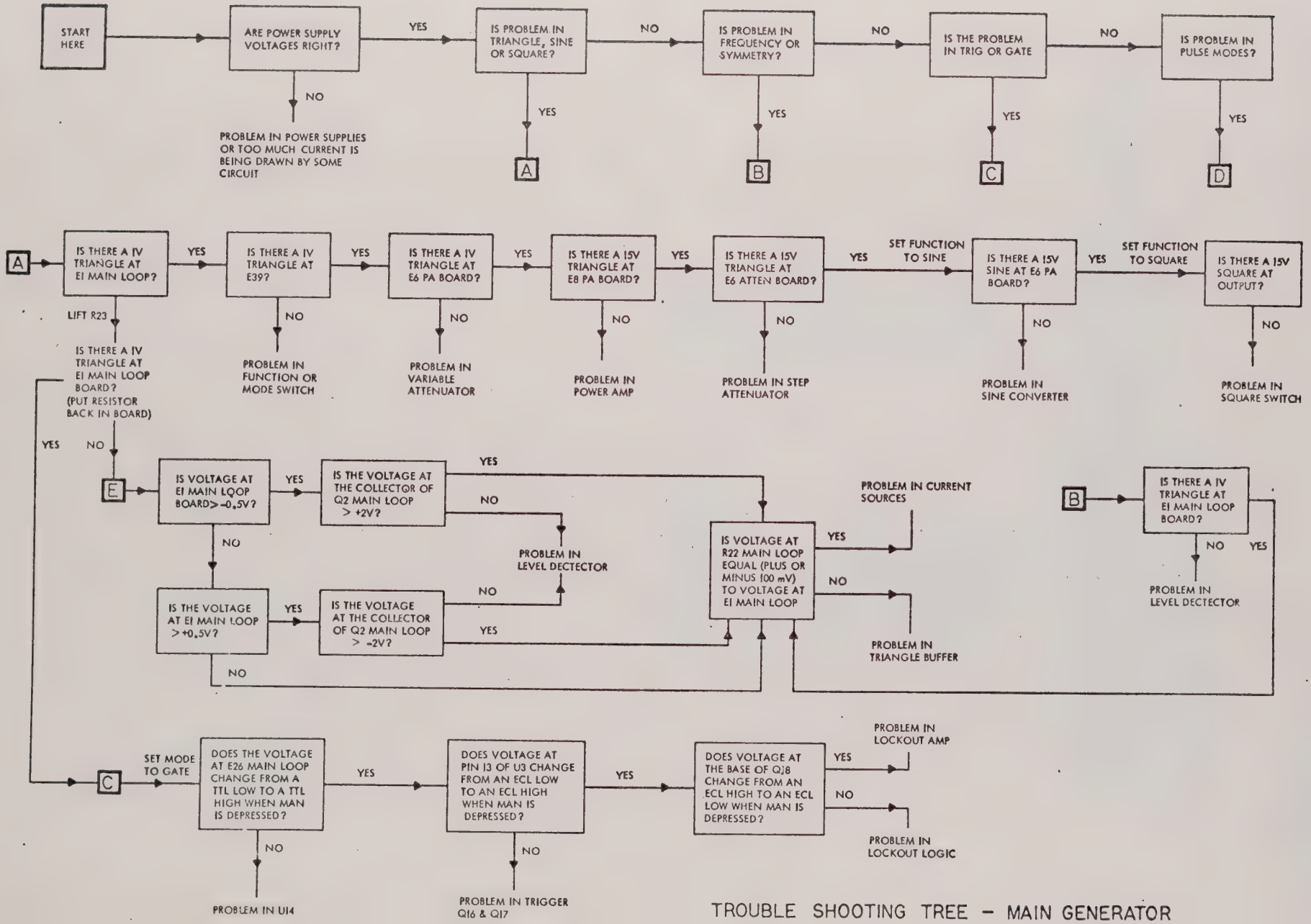
SECTION 4

TROUBLE SHOOTING

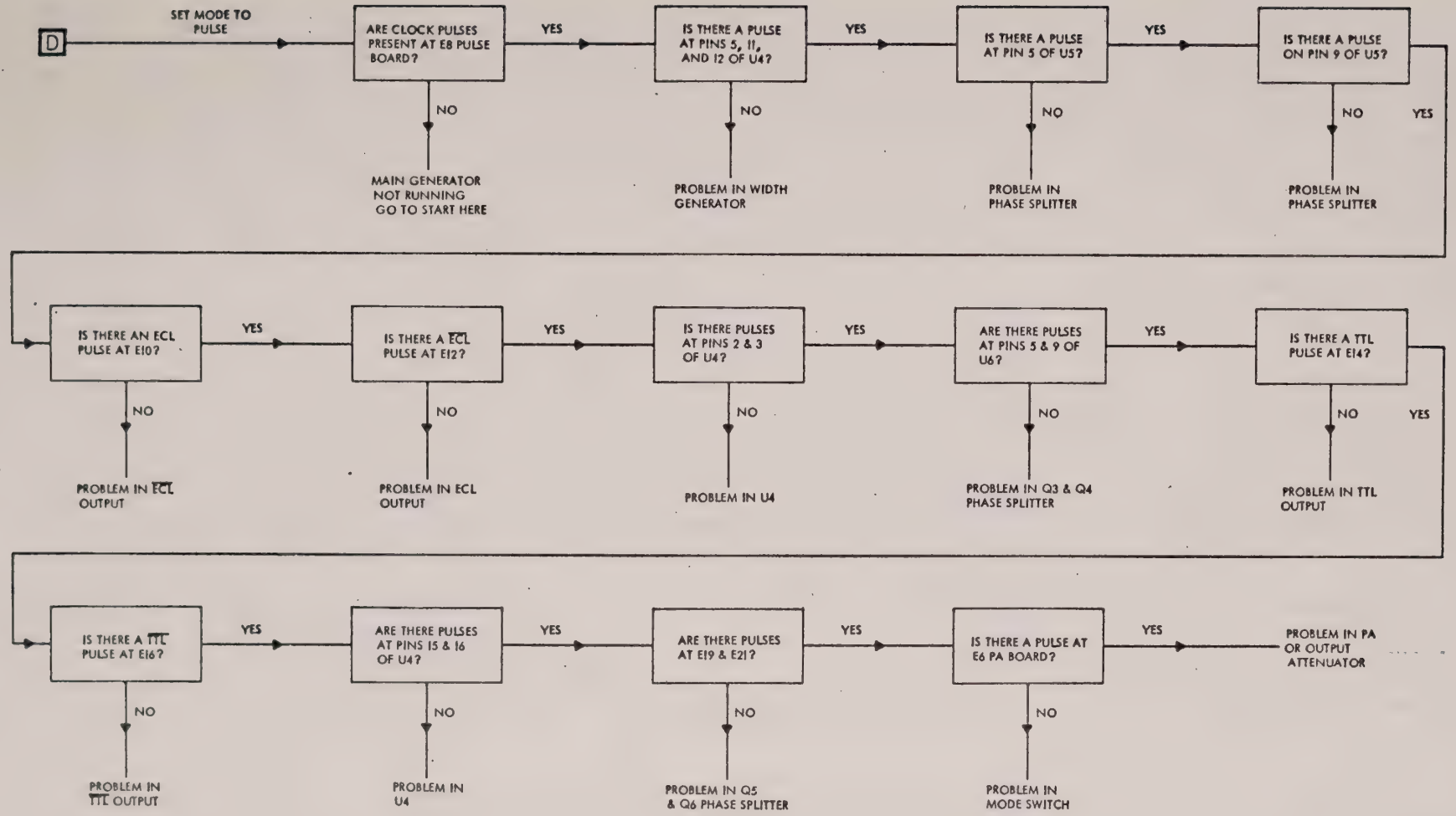
USE OF TROUBLE SHOOTING TREES

The trouble shooting trees are designed to point to the malfunctioning circuit block. Beyond this, refer to the proper schematic and check voltages and waveform at the indicated points to determine the actual problem. Start with the following initial control settings on the Model 734

MULTIPLIER	10
HZ/SEC	100HZ
FUNCTION	TRIANGLE
AMPLITUDE	FULL CW
OFFSET	OFF
ATTENUATORS	OFF
TRIG LEVEL	FULL CW
MODE	FUNCTION
RUN	DEPRESSED
SINGLE	OUT
GATE	OUT
PULSE DELAY	10 μ S
PULSE WIDTH	10 μ S
DELAY DOUBLE	NORMAL


START HERE
ARE POWER SUPPLY VOLTAGES RIGHT?
YES
NO
PROBLEM IN POWER SUPPLIES OR TOO MUCH CURRENT IS BEING DRAWN BY SOME CIRCUIT
IS PROBLEM IN TRIANGLE, SINE OR SQUARE?
NO
YES
A
IS PROBLEM IN FREQUENCY OR SYMMETRY?
NO
YES
B
IS THE PROBLEM IN TRIG OR GATE
NO
YES
C
IS PROBLEM IN PULSE MODES?
NO
YES
D
A
IS THERE A IV TRIANGLE AT E1 MAIN LOOP?
YES
NO
LIFT R23
IS THERE A IV TRIANGLE AT E1 MAIN LOOP BOARD? (PUT RESISTOR BACK IN BOARD)
YES
NO
IS THERE A IV TRIANGLE AT E39?
YES
NO
PROBLEM IN FUNCTION OR MODE SWITCH
IS THERE A IV TRIANGLE AT E6 PA BOARD?
YES
NO
PROBLEM IN VARIABLE ATTENUATOR
IS THERE A 15V TRIANGLE AT E8 PA BOARD?
YES
NO
PROBLEM IN POWER AMP
IS THERE A 15V TRIANGLE AT E6 ATTEN BOARD?
YES
NO
PROBLEM IN STEP ATTENUATOR
SET FUNCTION TO SINE
IS THERE A 15V SINE AT E6 PA BOARD?
YES
NO
PROBLEM IN SINE CONVERTER
SET FUNCTION TO SQUARE
IS THERE A 15V SQUARE AT OUTPUT?
YES
NO
PROBLEM IN SQUARE SWITCH
E
IS VOLTAGE AT E1 MAIN LOOP BOARD> -0.5V?
YES
NO
IS THE VOLTAGE AT THE COLLECTOR OF Q2 MAIN LOOP > +2V?
YES
NO
PROBLEM IN LEVEL DECTECTOR
IS THE VOLTAGE AT E1 MAIN LOOP > +0.5V?
YES
NO
IS THE VOLTAGE AT THE COLLECTOR OF Q2 MAIN LOOP > -2V?
YES
NO
IS VOLTAGE AT R22 MAIN LOOP EQUAL (PLUS OR MINUS 100 mV) TO VOLTAGE AT E1 MAIN LOOP
YES
PROBLEM IN CURRENT SOURCES
NO
PROBLEM IN TRIANGLE BUFFER
B
IS THERE A IV TRIANGLE AT E1 MAIN LOOP BOARD?
NO
YES
PROBLEM IN LEVEL DECTECTOR
C
SET MODE TO GATE
DOES THE VOLTAGE AT E26 MAIN LOOP CHANGE FROM A TTL LOW TO A TTL HIGH WHEN MAN IS DEPRESSED?
YES
NO
PROBLEM IN U14
DOES VOLTAGE AT PIN 13 OF U3 CHANGE FROM AN ECL LOW TO AN ECL HIGH WHEN MAN IS DEPRESSED?
YES
NO
PROBLEM IN TRIGGER Q16 & Q17
DOES VOLTAGE AT THE BASE OF Q18 CHANGE FROM AN ECL HIGH TO AN ECL LOW WHEN MAN IS DEPRESSED?
YES
PROBLEM IN LOCKOUT AMP
NO
PROBLEM IN LOCKOUT LOGIC

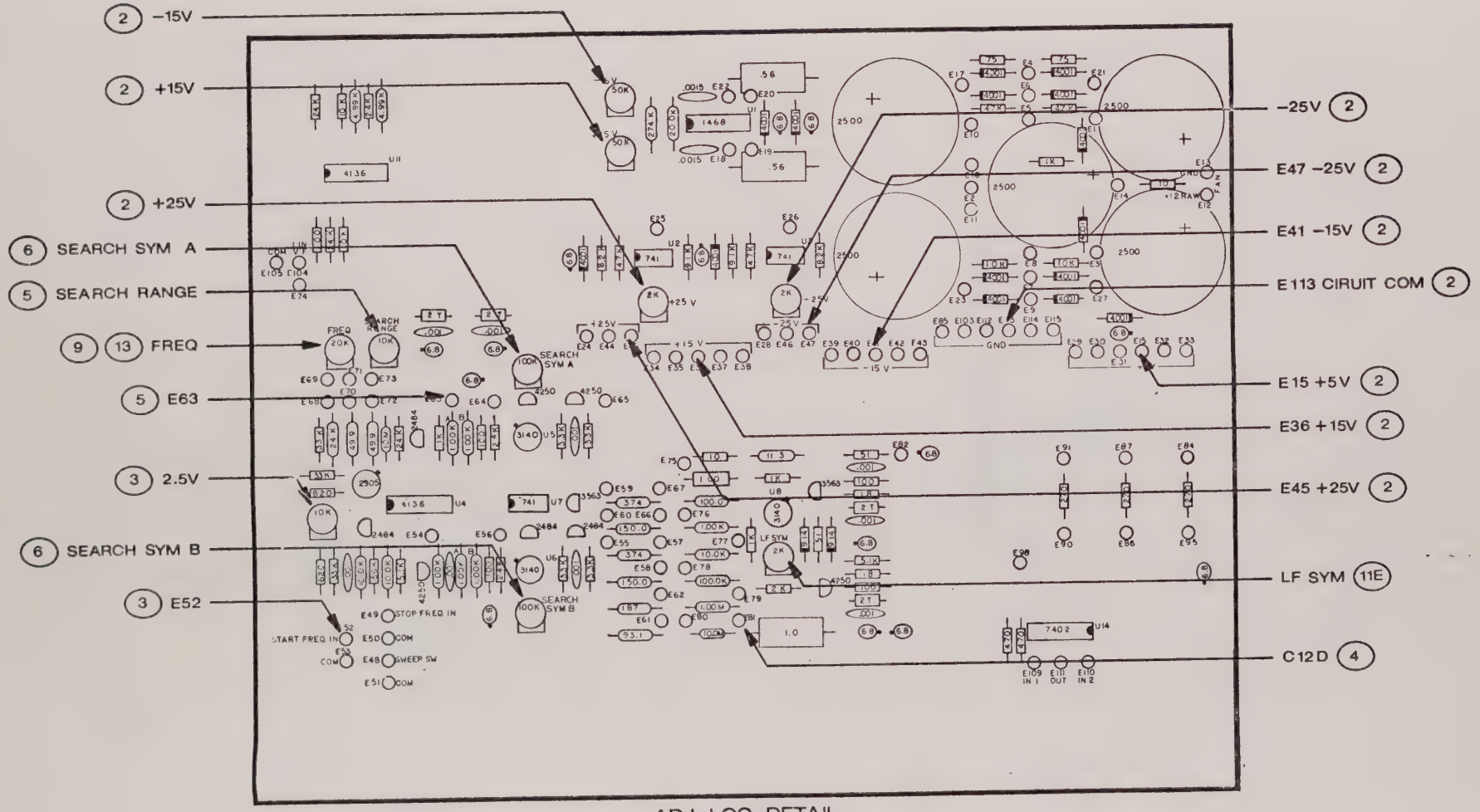
TROUBLE SHOOTING TREE – MAIN GENERATOR



TROUBLE SHOOTING TREE — PULSE GENERATOR

SECTION 5

CALIBRATION PROCEDURE



ADJ LOC DETAIL

PS/IS BD-A1

1. SET CONTROLS:

MAIN	
POWER	IN
MODE	FUNCTION
RUN	IN
SINGLE	OUT
ATTENUATORS	OFF
DC OFFSET	OFF
MULTIPLIER	10.0
HZ/SEC	100
FUNCTION	TRI
AMPLITUDE	MAX
TRIG LEVEL	CENTER
START LEVEL	CENTER
SYNC	NORMAL
DC OFFSET POT	CENTER
PULSE	
PULSE DELAY	10 μ sec VERNIER CW
PULSE WIDTH	10 μ sec VERNIER CW
DELAY DOUBLE	NORMAL

Note: OUTPUT and SYNC OUT must be properly terminated into 50Ω for measurements. Adjustments 2 through 6 are on power supplies board. See calibration location callouts.

2. Adjust +15V at E36 for +15.000V ± 2mV
   Adjust -15V at E41 for -15.000V ± 2mV
   Adjust +25V at E45 for +25.00V ± 10mV
   Adjust -25V at E47 for -25.00V ± 10mV

   Check for +4.80V to 5.20V at E15

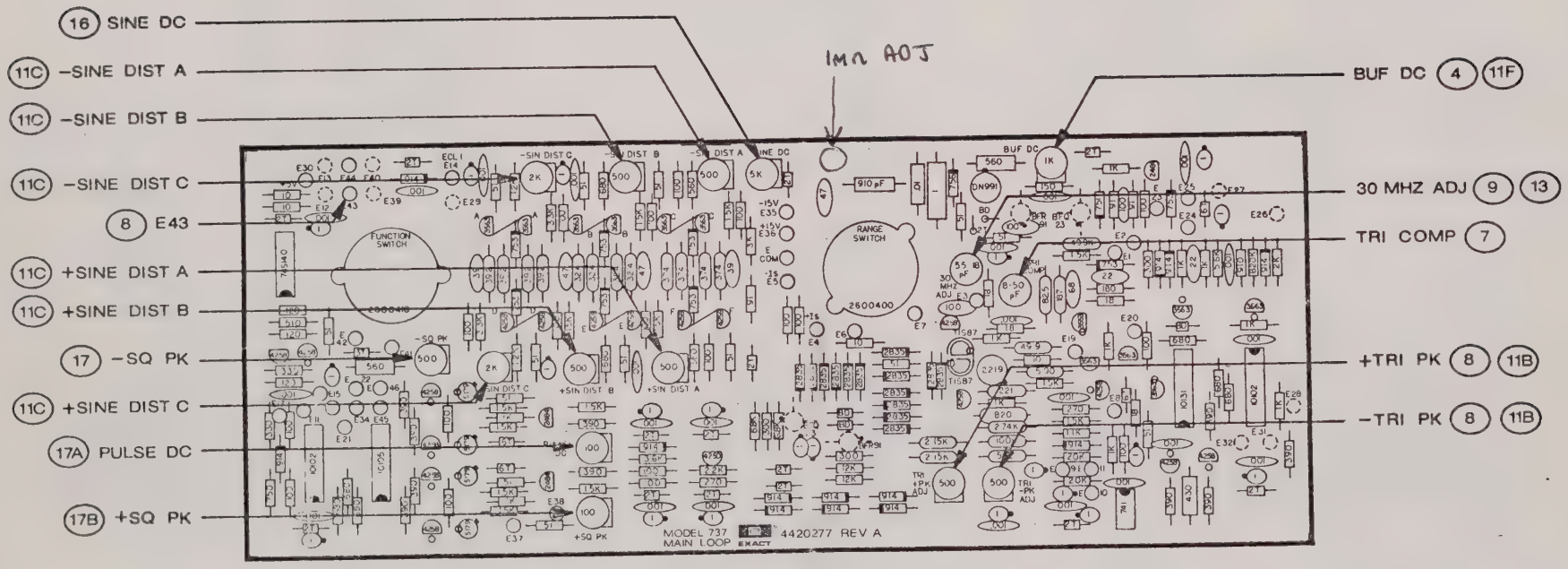
3. Adjust RAMP REF at E52 for 2.500V ± 1mV

4. Connect a X 10 probe across C12D and observe a triangle waveform on the oscilloscope. ADJUST the BUF DC so the triangle is symmetrical about ground. Disconnect the X 10 probe and reconnect the terminated OUTPUT to the oscilloscope input.

5. Set the MULTIPLIER to FREQ. and the large DIAL max CCW, set HZ/SEC to 100K. Adjust the SEARCH RANGE adj. For - 10mV ± 1mV at E63.

6. Adj SEARCH SYM A and SEARCH SYM B for a symmetrical period of approx. 1.2 MS on the oscilloscope.

Note: Adjustments 7, 8, and 9 are on Main Loop.



ADJ LOC DETAIL

MAIN LOOP BD-A2

7. Set the scope sweep speed to 1mS per division and return the MULTIPLIER to 10.0 Switch the HZ/SEC between 10K, 100K, and 1M. Adjust the TRI COMP with the HZ/SEC in the 1M position so the triangle peaks are the same amplitude as in the 100K and 10K positions.

8. Return the HZ/SEC to 100. Set the FUNCTION to sine. Adjust the +TRI PK and -TRI PK at E43 for ±0.460 V peak ±5mV. (x10 scope probe is required).

9. Connect the terminated SYNC OUT to a frequency counter. (Terminated SYNC OUT is a TTL level) Adjust the FREQ ADJ for approx. 1KHz. Set the HZ/SEC to 3M and adjust the 30MHz ADJ for approx. 30 MHz on the counter. Set the RANGE-Hz to 1M and adjust the 1MHz ADJ for approx. 10 MHz on the counter. (Fine adjustments occur later)

10. PA AMPLITUDE:
Set the HZ/SEC to 100, FUNCTION to triangle. Connect the terminated output to an oscilloscope with a voltage comparator.

    A. Set the AMPLITUDE to maximum CCW and set the scope sensitivity to 50 mV per division. Adjust the PA OFFSET adj. for a waveform symmetrical about ground.

    B. Set the AMPLITUDE maximum CW and set the scope sensitivity for 100 mV per division and the scope comparison voltage to 8.000V. Adjust the PA GAIN for an amplitude of 16.0V P-P. (The peaks will be offset from ground slightly).

    C. Repeat 10-A and B due to interaction.

11. SINE DISTORTION:
NOTE: When adjusting for minimum distortion it may be helpful to observe the the distortion products on an oscilloscope, (DISTORTION ANALYZER OUTPUT).
Set the FUNCTION to SINE. Observing on a scope with a voltage comparator, adjust SINE DC for a waveform symmetrical about ground.

    A. Connect the terminated OUTPUT to a distortion analyzer.

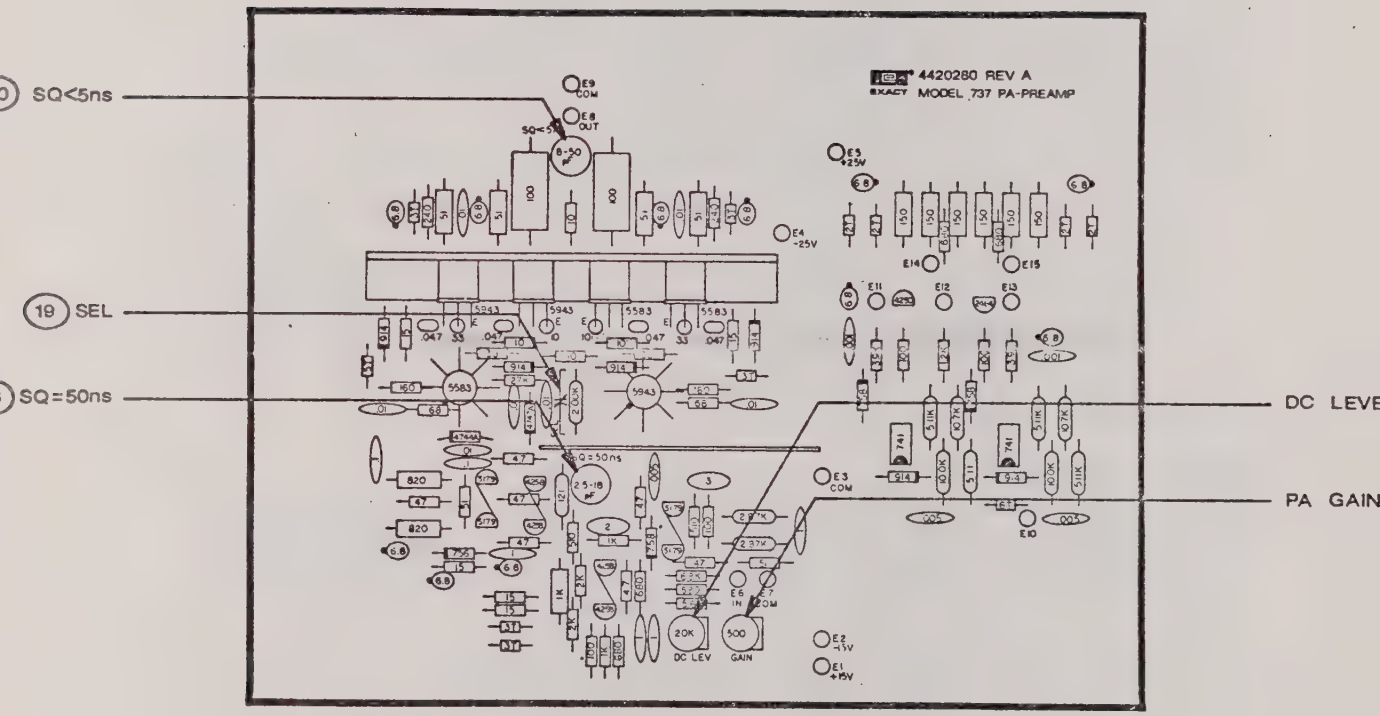
    B. Adjust + and - TRI PK adj. for minimum distortion.

    C. Adjust + and - SINE DIST adj. A,B, and C for minimum distortion.

    D. Check the distortion at HZ/SEC settings of 1K and 10K. Make adjustments as necessary for the best compromise. Typ. 0.3%.

    E. Set HZ/SEC to 10 and adjust LF SYM for lowest distortion.

    F. Set the HZ/SEC to 3M. Connect a 20 db pad between the unterminated OUTPUT coax and a spectrum analyzer. Observe the harmonics. No harmonics should be less than 30 db down from the fundamental. Adjustment of the BUF DC may be necessary to lower the 2nd harmonic.



ADJ LOC DETAIL

PA-PREAMP A3

12. MULT. KNOB
Return FUNCTION to triangle and HZ/SEC to 100. Connect the terminated OUTPUT to an oscilloscope. Observing one or two cycles displayed on the CRT, turn the MULTIPLIER large DIAL. Notice that near the end of rotation there is a "dead zone" where the frequency of the waveform displayed on the oscilloscope does not change as rapid as near the center of rotation. Adjust the large knob so that the "knee" where the "dead zone" starts is just past "x" on the FREQ. scale. Loosening of the set screws will be necessary for this adjustment. Make sure that the "knee" on the other end of the large DIAL is just below "0" on the FREQ. scale.

13. FREQUENCY
Set the FUNCTION to square wave and the MULTIPLIER to 10, HZ/SEC to 100 terminated OUTPUT to a frequency counter. Adjust the FREQ adj. for 1.00KHz. Check the HZ/SEC settings of 100, 1K, and 10K, a compromise may be necessary for all settings to meet spec. Set the HZ/SEC to 3M and adjust the 30 MHz adj. for 30.0MHz. Set the HZ/SEC to 1M and adjust the 1MHz adj. for 10.0 MHz.

14. Set the HZ/SEC to 100K and install the "sel" capacitor. This is a mica capacitor approx. 22pf. (This is factory installed, should not be necessary in the field)

15. Set the HZ/SEC to 10. Adjust the LOW FREQ adj. for 100 Hz. Check HZ/SEC settings of .01, 0.1, 1, and 10, a compromise may be necessary for all settings to meet spec.

16. AMPLITUDE
Set the HZ/SEC to 100 and FUNCTION to SINE. Connect the terminated OUTPUT to a comparator oscilloscope. Set the scope sensitivity for 100MV per division and the comparison voltage to 8.000V. Adjust the SINE DC adj. so the peaks are symmetrical about ground.

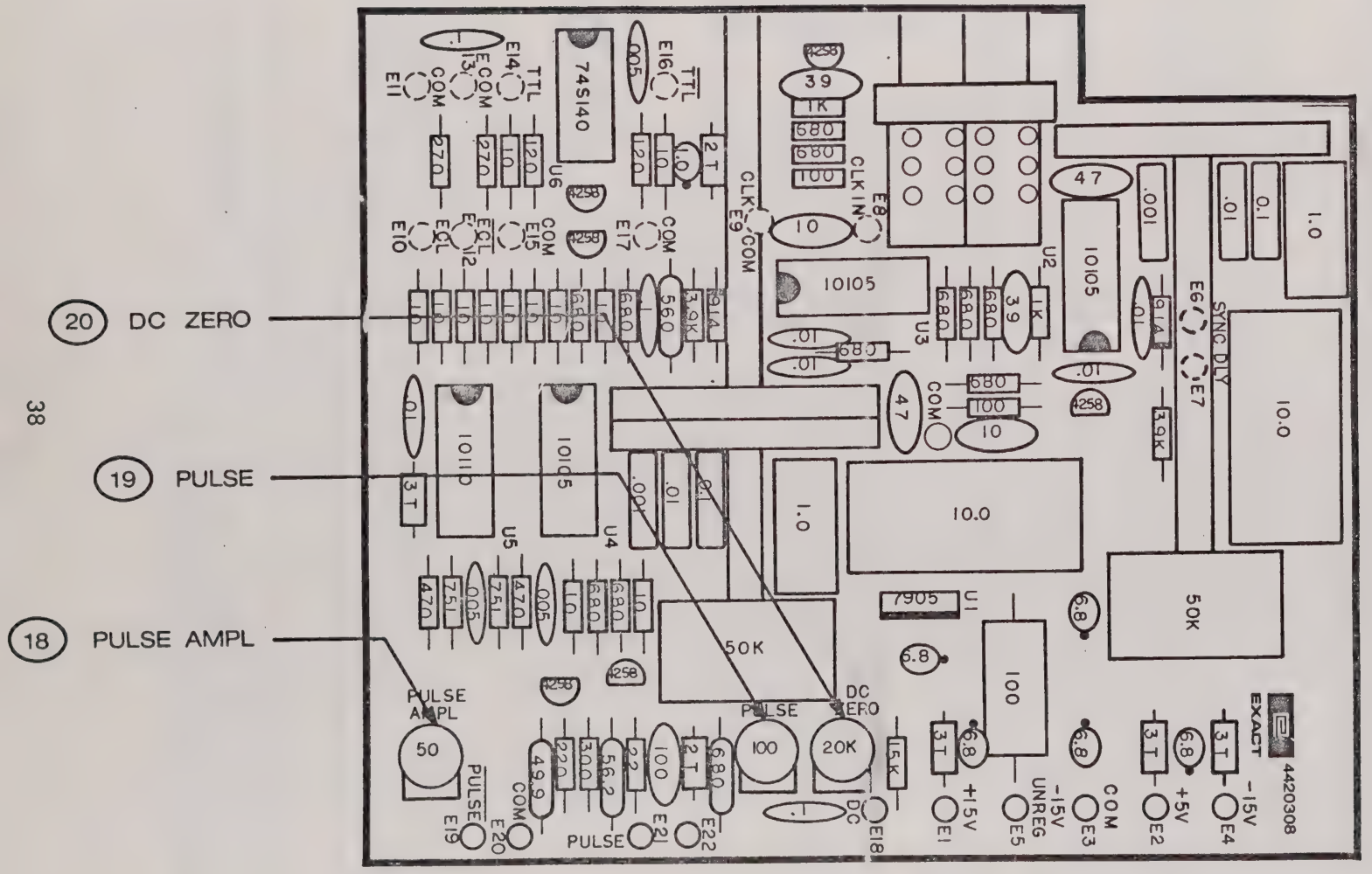
17. Set FUNCTION to neg. pulse. (Note: this is indicated by a negative going pulse waveform on the function switch) Adjust the -SQ PK adj. for -8.00V peak.

A. Disengaged the comparator offset on the scope. Adjust the PULSE DC adj. so the peaks are at ground level. Set FUNCTION to pos. pulse and notice the DC shift. It may be necessary to readjust the PULSE DC so that the levels are equal about ground.

B. Set the FUNCTION to pos. pulse. Adjust the +SQ PK for +8.00V peak.

18. P.A. RESPONSE
Set the FUNCTION to square wave. Adjust the AMPLITUDE so the square wave is 15 V P-P. Set the scope sweep speed to 50 ns per division. Set the HZ/SEC to 1M. Adjust the MULTIPLIER so that one cycle is displayed. Adjust the SQ-50NS adj. For the flatest response in the 20nS to 50 nS region immediately following the transition.

19. If overshoot is greater than 5%, adjust SEL capacitor to minimize the overshoot in the 10nS to 20nS Region.
Important: The SEL capacitor is adjusted by changing the spacing (Bending) of the two wires against the 2.00 K feedback resistor.



ADJ LOC DETAIL

PULSE GEN BD–A12

20. Some improvement of the high speed transitions can be obtained by adjusting the SQ -5nS adj. to effectively increase overshoot in the 5nS region. This adjustment should be made with care, as amplifier stability can be affected. Stability can best be observed by setting the oscilloscope at 1 μ S per division and HZ/SEC and MULTIPLIER for two cycles to be displayed over the full screen. (approx. 200 KHz). Switch the FUNCTION between pos and neg pulse and look for high frequency oscillations on the flat portions of the wave form.

21. Set controls as follows:

MULTIPLIER	10.0
HZ/SEC	100
MODE	PULSE
PULSE DELAY	100 μ S
VERNIER	CCW
PULSE WIDTH	100 μ S
VERNIER	CCW
DELAY	NORMAL
DOUBLE	NORMAL
AMPLITUDE	MAX CW

Adjust the PULSE AMP for -8.00V peak.

22. Set the MODE to PULSE and adjust PULSE ADJ for +8.00V peak.

23. Set the MODE to DC and adjust DC ZERO for 0.00V.

SECTION 6

PARTS LIST

CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
[illegible]	U.S.A. Common	Any supplier of U.S.
00126	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidail Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Prod. Div	Camden, N.J.
[illegible]	Aerovox Corp.	New Bedford, Mass
00779	Amp, Inc	Harrisburg, Pa
00781	Aircraft Radio Corp.	Boonton, N.J.
00915	Northern Eng. Labs, Inc	Burlington, Wis.
00853	Sangamo Electric Co. Ordill Div. (Caps)	Marion, Illinois
00866	Gow Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Prod. Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassis-Trak Corp.	Indianapolis, Inc.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Illinois
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp/Amer.	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg El. Corp.	Chicago, Illinois
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Company of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y
03705	Apex Machine and Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Electric Co	Hartford, Conn
040.3	Taurus Corp.	Lambertville, N.J.
04062	Elmenco Products Co.	New York, N.Y.
04272	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin Nutional Watch Co. Electronics Div	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Illinois
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif
04651	Sylvania Electronic Prod., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola/Semicon. Prod.	Phoenix, Ari. ona
04732	Fitman Co/Western Div.	Culver City, Calif.
04773	Automatic Electric Co	Northlake, Illinois
04777	Automatic Elect. Sales Corp.	Northlake, Illinois
04796	Sequoia Wire Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Co.	Chicago, Illinois
05006	20th Century Plastics	Los Angeles, Calif.
05277	Westinghouse/Semicon Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Eng. Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Illinois
05728	Tiffen Optical Co	Roslyn Heights, L.I., N.Y.
05729	Metropolitan Telecomm. Corp Metro Cap Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical	Rochester, N.Y.
06402	E.T.A. Products/Amer.	Chicago, Illinois
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Elect. Hardware Co.	New Rochelle, N.Y.
06555	Beede Electrical Instr. Co.	Penacook, N.H.
06751	U.S. Semicon Div of Nuclear Corp. Amer.	Phoenix, Ariz
06812	Farrington Mfg Co, West Div.	Van Nuys, Calif
06828	Kelvin Electric Co.	Van Nuys, Calif
07115	Corning Glass Work's Electronics Comp. Dept.	Bradford, Pa.
07126	Digitron Co	Pasadena, Calif.
07137	Transistor Electronics Corp	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07533	Cinch-Graphik Co.	City of Industry, Calif.
07561	Avnet Corp.	Los Angeles, Calif.
07262	Fairchild Semiconductor Corp	Mountain View, Calif
07327	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Bircher Corp	Los Angeles, Calif.
07735	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Sheckley Semi-Conductor Labs	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Brint, Nelhart Co.	Pomona, Calif.
08338	Burgess Battery Co.	Niagara Falls, Ontario
08717	Sloan Company	Burbank, Calif
08718	Connon Elect Co, Phoenix Div	Phoenix, Ariz.
08792	CBS Elect. Semiconductor Oper., Div. C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc	Costa Mesa, Calif.
09034	Texas Capacitor Co.	Houston, Texas
09145	Atomn Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Illinois
09569	Mallory Battery Co/Canada Ltd	Toronto, Ontario, Canada
09664	The Bristol Company	Waterbury, Conn.
10218	Gen. Trans. Western Corp.	Los Angeles, Calif
10411	Ti-Tal, Inc	Berkeley, Calif.
10597	Exact Electronics, Inc	Hillsboro, Oreg.
10646	Carborundum Co	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind
11237	Chicago Tel. of Calif., Inc	S. Pasadena, Calif.
11312	Microwave Elect. Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc	Santa Ana, Calif.
11711	Gen Trans/Semiconductor Div	Newark, N.J
11757	Imperial Electronics, Inc.	Buena Park, Calif

Code No.	Manufacturer	Address
11870	Metalix, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Elect. Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermalloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components Inc.	Conshohocken, Pa.
14655	Cornell Dubilier El. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Elect., Co., Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Mollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Daven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16352	Computer Diode Corp.	Lodi, N.J.
16688	De Jur-Amsco Corp.	Long Island City, N.Y.
16758	Delco Radio, Division of G.M. Corp.,	Kokomo, Ind.
17109	Thermetrics, Inc.	Canoga Park, Calif.
17474	Tranes Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Illinois
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. Dupont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. McGraw-Edison Co.	West Orange, N.J.
19701	Electro Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Illinois
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E. Lamp Div.	Neta Park, Cleveland, Ohio
24655	General Radio Co.	W. Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co/America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	GE Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm, Inc.	Chicago, Ill.
36196	Stanwyck Corp.	Hawkesburn, Ontario, Cd.
37942	P.R. Mallory and Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod.	Akron, Ohio
40920	Miniature Precision Bearings	Keene, N.H.
42190	Muter Co.	Chicago, Illinois
42990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Illinois
47904	Palomar Corp.	Cambridge, Mass.
48620	Precision Thermometer/Inst.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
53743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Illinois
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson and Co., Inc.	S. Norwalk, Conn
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	N. Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas and Betts Co.	Elizabeth, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc	New York, N.Y.
65092	West Inst. Div. Daystrom	Newark, N.J.
66295	Witten Manufacturing Co.	Chicago, Illinois
66346	Weltronic Optical Co.	Rochester, N.Y.
70276	Allen Manufacturing Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Altmetal Screw Prod. Co, Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works	Chicago, Illinois
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Manufacturing Co.	Chicago, Illinois
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Elect. Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Illinois
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif
71482	C.P. Clare and Co.	Chicago, Illinois
71590	Cannrads, Div. Globe Union, Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Illinois
71700	The Cornish Wire Co	New York, N.Y.
71744	Chicago Miniature Lamp Wks	Chicago, Illinois
71785	A. O. Smith Corp. Crowley Div.	West Orange, N.J.
71984	Cinch Mfg. Corp.	Chicago, Illinois
72092	Daw Carving Corp.	Midland, Mich.
72136	Eitel-McCullough, Inc.	San Bruno, Calif.
72324	Electra Motive Mfg. Co, Inc.	Willimantic, Conn.
72365	John E Fast and Company	Providence, R.I.
72619	Dialight Corp.	Chicago, Illinois
72656	General Ceramics Corp.	Brooklyn, N.Y.
72699	General Instrument Corp. Semiconductor Div.	Keasbey, N.J. Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Illinois
72825	Hugh M. Eby, Inc.	Philadelphia, Pa.
72928	Guideman Co.	Chicago, Illinois
72965	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa
73061	Hansen Mfg. Co., Inc	Princeton, Ind.
73076	H. M. Harper Co.	Chicago, Illinois
73138	Helipot, Div. Beckman Instruments, Inc.	Fullerton, Calif.

Code No.	Manufacturer	Address
73293	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. No. American Philips Co., Inc.	Hicksville, N.Y.
73490	Bekteman Helipot Corp.	S. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Curtiss Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Illinois
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co	Elyria, Ohio
73846	Graphen Stamping and Tool	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite, Inc.	Neptune, N.J.
74455	J. M. Wood and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Illinois
74868	R.F. Prod. Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Div. of Cinch Mfg. Corp.	Chicago, Illinois
75378	James Knights Co.	Sandwich, Illinois
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Illinois
75915	Littlefuse, Inc.	Des Plaines, Illinois
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif
76433	Micamold Electronic Mfg. Corp	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Illinois
77068	Bendix Pacific Div. of Bendix Corp.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostron Instrument and Electronic Co.	S. Pasadena, Calif.
77250	Phaall Manufacturing Co	Chicago, Illinois
77252	Philadelphia Steel and Wire Corporation	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine/Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof, Div. of Illinois Tool Works	Elgin, Illinois
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn, Inc.	Pitman, N.J.
78452	Thompson-Bremer and Co.	Chicago, Illinois
78471	Tilley Manufacturing Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass
79142	Veeder-Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Illinois
79727	Continental-Wirt Elect. Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco, Electra Corp. Sections Clock Company	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Timas Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Assoc. Any brand tube meeting EIA standards.	Washington D.C.
80207	Unimax Switch, Div. of W L Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Illinois
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro, Div. Robershaw Fulton Controls Co.	Columbus, Ohio Columbus, Ohio
80486	All Star Products, Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Graphitl Co.	LaGrange, Illinois
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co.	Norwalk, Conn.
81349	Military Specifications	. . . . .
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div, Industrial Tube Oper.	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Illinois
82142	Jeffers Electronics, Div. of Speer Carbon Co.	Dubois, Pa.
82170	Allan B. Dumont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Electronic Tube Div.	Emporium, Pa.
82376	Astron Corp.	E. Newark, N.J.
82389	Switchcraft, Inc.	Orange, Illinois
82647	Metals and Controls, Inc., Div. Texas Instruments, Spencer Products	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wisc.
82877	Ratron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83033	Western Washer Mfr. Co.	Los Angeles, California
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp/Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Illinois
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Illinois
83501	Gavin Wire and Cable Co., Div. Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.

Code No.	Manufacturer	Address
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scrugge Co.	Festus, Mo.
84171	Arco Electronics, Inc	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Co.	Boonton, N.J.
85474	R M. Bracamonte and Co.	San Francisco, Calif.
85660	Rolled Rack, Inc.	New Haven, Conn
85911	Seamless Rubber Co.	Chicago, Illinois
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N. J.
87216	Philco Corp. (Lansing Div.)	Lansing, Pa.
87473	Western Fibrous Glass Products Co	San Francisco
87664	Van Waters and Rogers, Inc.	Seattle, Wash.
87930	Tcmer Mfg. Co.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Illinois
88270	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif
89462	Welded Rahinoar, Inc.	Cambridge, Mass.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baker Co.	Chicago, Illinois
89665	United Transformer Co.	Chicago, Illinois
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif
91345	Miller Dial and Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Illinois
91506	August Brothers', Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Neb.
91662	Elco Corp.	Philadelphia
91737	Gremar Mfg Co., Inc.	Wakefield, Mass.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Illinois
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Basset Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod, Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith, Inc.	Port Monmouth, N.J.
93929	G.V. Controls	Livingston, N.J.
93983	Insuline/Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Mfg. Co., Industrial Comp. Div, Rec. Tube Div.	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div, Calif. St. Plt	Newton, Mass.
94148	Scientific Radio Products	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtis-Wright Corp. Electronics Div.	E. Paterson, N.J.
94222	Southco, Div. S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod., Div. Model Engineering and Mfg. Co.	Chicago, Illinois
94330	Wire Cloth Products, Inc.	Chicago, Illinois
94682	Worcester Pressed Alum. Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Illinois
95712	Doge Electric Co., Inc.	Franklin, Ind.
95987	Westsewer Co.	Chicago, Illinois
96067	Huggins Laboratories	Sunnyvale, Calif
96095	Hi-Q Div. of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif
96330	Carlton Screw Co.	Chicago, Illinois
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg.	Yonkers, N.Y.
97966	CBS Electronics Div. C.B.S., Inc.	Danvers, Mass.
97979	Ikon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gurdena, Calif
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	S. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Corad Corp.	Redmond City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp	New York, N.Y.
99213	Varian Associates	Palo Alto, Calif
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Div, Controls Co. of America	El Segundo, Calif
99800	Delevan Electronics Corp.	E. Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind
99934	Renbrandt, Inc	Boston, Mass
99942	Hoffman Semiconductor Div of Hoffman Electronics Corp.	Evanston, Illinois
99957	Technology Instrument Corp. of California	Newbury Park, Calif.

PART	DESCRIPTION	EXACT NO	MFG
A1	POWER SUPPLY & CURRENT SORCES PCB ASSY		
A1 C001	CAPACITOR, 2500MFD 35V	2900034.	853.
A1 C002	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C003	CAPACITOR, 2500MFD 35V	2900034.	853.
A1 C004	CAPACITOR, 2500MFD 35V	2900034.	853.
A1 C005	CAPACITOR, 1500 PF DISC	2830012.	91418.
A1 C006	CAPACITOR, 1500 PF DISC	2830012.	91418.
A1 C007	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C008	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C009	CAPACITOR, 2500MFD 35V	2900034.	853.
A1 C010	CAPACITOR, 2500MFD 35V	2900034.	853.
A1 C011	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C012	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C013	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C014	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C015	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C016	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C017	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C018	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C019	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C020	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C021	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C027	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C028	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C029	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A1 C030	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C035	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 C036	CAPACITOR, 1000 PF DISC	2830000.	91418.
A1 D001	TO		
A1 D015	DIODE, 1N4001	1524001.	1295.
A1 D016	DIODE, 1N914	1520914.	7910.
A1 D017	DIODE, 1N914	1520914.	7910.
A1 L001	TO		
A1 L004	CHOKE 2 TURN BEAD	1140029.	10597.
A1 Q001	TRANSISTOR, EN2484	1562484.	7263.
A1 Q002	TRANSISTOR, 2N2905	1562905.	1295.
A1 Q003	TRANSISTOR, EN2484	1562484.	7263.
A1 Q004	TO		
A1 Q006	TRANSISTOR, 2N4250	1564250.	7263.
A1 Q007	TRANSISTOR, EN2484	1562484.	7263.
A1 Q008	TRANSISTOR, EN2484	1562484.	7263.
A1 Q009	TRANSISTOR, MPS3563	1563563.	4713.
A1 Q010	TRANSISTOR, MPS3563	1563563.	4713.
A1 Q011	TRANSISTOR, 2N4250	1564250.	7263.
A1 R001	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A1 R002	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A1 R003	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A1 R004	RESISTOR, 75 OHM 1/4W 5% CARBON	3070750.	1121.
A1 R005	RESISTOR, 0.56 OHM 2W WIREWOUN	3080005.	75042.
A1 R006	RESISTOR, 75 OHM 1/4W 5% CARBON	3070750.	1121.
A1 R007	RESISTOR, 0.56 OHM 2W WIREWOUN	3080005.	75042.
A1 R008	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743.	7115.
A1 R009	POTENTIOMETER, 50K OHM TRIM	3110350.	71450.
A1 R010	RESISTOR,20000 OHM 1/4W 1% METAL FILM	3132002.	7115.
A1 R011	POTENTIOMETER, 50K OHM TRIM	3110350.	71450.
A1 R012	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103.	1121.
A1 R013	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103.	1121.
A1 R014	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A1 R015	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822.	1121.
A1 R016	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A1 R017	RESISTOR, 9100 OHM 1/4W 5% CARBON	3070912.	1121.
A1 R018	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
A1 R019	RESISTOR, 9100 OHM 1/4W 5% CARBON	3070912.	1121.
A1 R020	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A1 R021	RESISTOR, 8200 OHM 1/4W 5% CARBON	3070822.	1121.
A1 R022	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A1 R023	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A1 R024	RESISTOR, 56K OHM 1/4W 5% CARBON	3070563.	1121.
A1 R025	POTENTIOMETER, 10K OHM TRIM	3110349.	71450.
A1 R026	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512.	1121.
A1 R027	RESISTOR, 620 OHM 1/4W 5% CARBON	3070621.	1121.
A1 R028	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A1 R029	RESISTOR, 124K OHM 1/4W 1% METAL FILM	3131243.	7115.
A1 R030	RESISTOR, 49.9K OHM 1/4W 1% METAL FILM	3134992.	7115.
A1 R031	RESISTOR,10000K OHM 1/2W 1% DEP. CARBON	3091005.	75042.
A1 R032	POTENTIOMETER, 10K OHM TRIM	3110349.	71450.
A1 R033	RESISTOR, 49.9K OHM 1/4W 1% METAL FILM	3134992.	7115.
A1 R034	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A1 R035	POTENTIOMETER, 20K TRIM	3110355.	0.
A1 R036	RESISTOR, 33K OHM 1/4W 5% CARBON	3070333.	1121.
A1 R037	RESISTOR, 24K OHM 1/4W 5% CARBON	3070243.	1121.
A1 R038	RESISTOR, 820 OHM 1/4W 5% CARBON	3070821.	1121.
A1 R039	RESISTOR, 1000 OHM MATCHED PAIR	3121001.	10597.
A1 R040	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A1 R041	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242.	1121.
A1 R042	POTENTIOMETER, 10K OHM TRIM	3110349.	71450.
A1 R043	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R044	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A1 R045	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A1 R046	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500.	7115.
A1 R047	RESISTOR, 374 OHM 1/4W 1% METAL FILM	3133740.	7115.
A1 R048	RESISTOR, 1000 OHM MATCHED PAIR	3121001.	10597.
A1 R049	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001.	7115.
A1 R050	POTENTIOMETER, 10K OHM TRIM	3110349.	71450.
A1 R051	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R052	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242.	1121.
A1 R053	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A1 R054	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A1 R055	RESISTOR, 374 OHM 1/4W 1% METAL FILM	3133740.	7115.
A1 R056	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500.	7115.
A1 R057	RESISTOR, 93.1 OHM 1/4W 1% METAL FILM	3130931.	7115.
A1 R058	RESISTOR, 187 OHM 1/4W 1% METAL FILM	3131870.	7115.
A1 R059	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A1 R060	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3010010.	1121.
A1 R061	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000.	7115.
A1 R062	RESISTOR, 1000 OHM 1/4W 1% METAL FILM	3131001.	7115.
A1 R063	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A1 R064	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003.	7115.
A1 R065	RESISTOR, 1000K OHM 1/4W 1% METAL FILM	3131004.	7115.
A1 R066	RESISTOR,10000K OHM 1/2W 1% DEP. CARBON	3091005.	75042.
A1 R067	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150.	1121.
A1 R068	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A1 R069	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A1 R070	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A1 R071	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202.	1121.
A1 R072	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R073	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A1 R074	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A1 R075	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A1 R076	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A1 R077	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512.	1121.
A1 R078	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R079	TO		
A1 R081	RESISTOR, 270 OHM 1/4W 5% CARBON	3070271.	1121.
A1 R100	RESISTOR, 10K OHM 1/4W 5% CARBON	3070103.	1121.
A1 R101	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A1 R102	RESISTOR, 24K OHM 1/4W 5% CARBON	3070243.	1121.
A1 R103	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A1 R120	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A1 R121	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A1 R123	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220.	1121.
A1 R124	POTENTIOMETER, 100 OHM TRIM	3110345.	71450.
A1 U001	INTEGRATED CIRCUIT,SG45G1	1584502.	10597.
A1 U002	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A1 U003	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A1 U004	INTEGRATED CIRCUIT, 4136 QUAD O	1584136.	0.
A1 U005	OP AMP, CA3140S	1583140.	2735.
A1 U006	OP AMP, CA3140S	1583140.	2735.
A1 U007	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A1 U008	OP AMP, CA3140S	1583140.	2735.
A1 U011	INTEGRATED CIRCUIT, 4136 QUAD O	1584136.	0.
A1 U014	INTEGRATED CIRCUIT, SN7402N	1580021.	1295.
A2	LOOP PCB ASSY		
A2 C001	CAPACITOR, 8-50PF TRIM	2810022.	72982.
A2 C002	CAPACITOR, 68PF MICA	2810523.	853.
A2 C003	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C004	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C005	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C006	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C008	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C009	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C010	CAPACITOR, 22PF MICA	2810530.	853.
A2 C011	CAPACITOR, 5.5-18PF TRIM	2810011.	72982.
A2 C012	CAPACITOR, TIMING SET	2950002.	10597.
A2 C015	CAPACITOR, 5.5-18PF TRIM	2810011.	72982.
A2 C016	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C017	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C018	CAPACITOR, 100PF MICA	2810537.	853.
A2 C019	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C020	CAPACITOR, 100PF MICA	2810537.	853.
A2 C021	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C022	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C023	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C024	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C025	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C026	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C027	CAPACITOR, 220PF MICA	2810555.	853.
A2 C028	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C029	TO		
A2 C031	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C032	CAPACITOR, 100PF MICA	2810537.	853.
A2 C033	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C034	CAPACITOR, 220PF MICA	2810555.	853.
A2 C035	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C036	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C037	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C038	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C039	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C040	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C041	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C042	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C043	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C044	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C045	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C046	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C047	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C048	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C049	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C050	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C051	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C052	CAPACITOR, 47PF MICA	2810532.	853.
A2 C054	CAPACITOR, 39PF MICA	2810531.	853.
A2 C055	CAPACITOR, 39PF MICA	2810531.	853.
A2 C057	CAPACITOR, 47PF MICA	2810532.	853.
A2 C058	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C059	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C060	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C061	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C062	CAPACITOR, 1000 PF DISC	2830000.	91418.
A2 C063	CAPACITOR, 1MFD 35V	2900046.	56289.
A2 C064	CAPACITOR, SELECTED VALUE		
A2 C065	CAPACITOR, SELECTED VALUE		
A2 D001	TO		
A2 D006	DIODE, HOT CARRIER	1522835.	10597.
A2 D007	TO		
A2 D012	DIODE, 1N914	1520914.	7910.
A2 D013	TO		
A2 D020	DIODE, HOT CARRIER	1522635.	10597.
A2 D021	DIODE, 1N756	1520756.	1295.
A2 D022	DIODE, 1N753A	1520753.	1295.
A2 D023	DIODE, 1N751A	1520751.	75042.
A2 D024	TO		
A2 D027	DIODE, 1N914	1520914.	7910.
A2 D028	DIODE, 1N753A	1520753.	1295.
A2 D029	DIODE, 1N914	1520914.	7910.
A2 D030	DIODE, 1N914	1520914.	7910.
A2 D031	TO		
A2 D036	DIODE, 1N753A	1520753.	1295.
A2 D037	DIODE, 1N914	1520914.	7910.
A2 L001	TO		
A2 L004	BEAD, FERRITE G303	1140034.	1121.
A2 L005	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L007	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L008	CHOKE 2 TURN BEAD	1140029.	10597.

PART	DESCRIPTION	EXACT NO	MFG
A2 L009	BEAD, FERRITE G303	1140034.	1121.
A2 L010	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L011	BEAD, FERRITE G303	1140034.	1121.
A2 L012	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L013	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L014	CHOKE 6 TURN BEAD	1140032.	10597.
A2 L015	TO		
A2 L017	BEAD, FERRITE G303	1140034.	1121.
A2 L018	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L019	BEAD, FERRITE G303	1140034.	1121.
A2 L020	BEAD, FERRITE G303	1140034.	1121.
A2 L021	CHOKE 6 TURN BEAD	1140032.	10597.
A2 L022	BEAD, FERRITE G303	1140034.	1121.
A2 L023	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L024	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L025	TO		
A2 L028	BEAD, FERRITE G303	1140034.	1121.
A2 L029	CHOKE 6 TURN BEAD	1140032.	10597.
A2 L030	CHOKE 2 TURN BEAD	1140029.	10597.
A2 L031	TO		
A2 L034	BEAD, FERRITE G303	1140034.	1121.
A2 L035	CHOKE 6 TURN BEAD	1140032.	10597.
A2 L036	CHOKE 3 TURN BEAD	1140030.	10597.
A2 L037	TO		
A2 L041	CHOKE 2 TURN BEAD	1140029.	10597.
A2 Q001	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q002	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q003	TRANSISTOR, TIS87	1560087.	1295.
A2 Q004	TRANSISTOR, TIS87	1560087.	1295.
A2 Q005	TRANSISTOR, 2N2219	1562219.	1295.
A2 Q006	TRANSISTOR, BFQ23	1560023.	0.
A2 Q007	TRANSISTOR, BFR91	1560091.	0.
A2 Q008	TRANSISTOR, DN991	1560991.	10597.
A2 Q009	TRANSISTOR, BFR91	1560091.	0.
A2 Q010	TRANSISTOR, BFQ23	1560023.	0.
A2 Q011	TRANSISTOR, EN2484	1562484.	7263.
A2 Q012	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q013	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q014	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q015	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q016	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q017	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q018	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q019	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q020	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q021	TRANSISTOR, MPS3563	1563563.	4713.
A2 Q022	TO		
A2 Q024	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q025	TRANSISTOR, 2N5179	1565179.	4713.
A2 Q026	TRANSISTOR, 2N5179	1565179.	4713.
A2 Q027	TRANSISTOR, EN2484	1562484.	7263.
A2 Q028	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q029	TRANSISTOR, 2N4258	1564258.	7263.
A2 Q030	TRANSISTOR, 2N5179	1565179.	4713.
A2 Q031	TRANSISTOR, 2N5179	1565179.	4713.
A2 Q032	TRANSISTOR, EN2484	1562484.	7263.
A2 Q033	TRANSISTORS, MATCHED MPS3563	1573563.	10597.
A2 Q034	TRANSISTORS, MATCHED 2N4258	1574258.	10597.
A2 Q035	TRANSISTORS, MATCHED MPS3563	1573563.	10597.
A2 Q036	TRANSISTORS, MATCHED 2N4258	1574258.	10597.
A2 Q037	TRANSISTORS, MATCHED MPS3563	1573563.	10597.
A2 Q038	TRANSISTORS, MATCHED 2N4258	1574258.	10597.
A2 Q039	TRANSISTOR, 2N4250	1564250.	7263.
A2 QX01	HEAT CLIP	2000109.	13103.
A2 QX02	TO		
A2 R001	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A2 R002	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R003	RESISTOR, 221 OHM 1/4W 1% METAL FILM	3132210.	7115.
A2 R004	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R005	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R006	RESISTOR, 187 OHM 1/4W 1% METAL FILM	3131870.	7115.
A2 R007	RESISTOR, 82.5 OHM 1/4W 1% METAL FILM	3130825.	7115.
A2 R008	RESISTOR, 562 OHM 1/4W 1% METAL FILM	3135620.	7115.
A2 R009	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A2 R010	RESISTOR, 2740 OHM 1/4W 1% METAL FILM	3132741.	7115.
A2 R011	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R012	RESISTOR, 2150 OHM 1/4W 1% METAL FILM	3132151.	7115.
A2 R013	RESISTOR, 2150 OHM 1/4W 1% METAL FILM	3132151.	7115.
A2 R014	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R015	RESISTOR, 820 OHM 1/2W 5% CARBON	3010821.	1121.
A2 R016	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301.	1121.
A2 R017	RESISTOR, 12K OHM 1/4W 5% CARBON	3070123.	1121.
A2 R018	RESISTOR, 12K OHM 1/4W 5% CARBON	3070123.	1121.
A2 R019	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301.	1121.
A2 R020	RESISTOR, 6800 OHM 1/4W 5% CARBON	3070682.	1121.
A2 R021	RESISTOR, 6800 OHM 1/4W 5% CARBON	3070682.	1121.
A2 R022	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A2 R023	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A2 R024	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A2 R025	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R026	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R027	RESISTOR, 560 OHM 1/2W 5% CARBON	3010561.	1121.
A2 R028	RESISTOR, 150 OHM 1/4W 5% CARBON	3070151.	1121.
A2 R029	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R030	POTENTIOMETER, 5K OHM TRIM	3110354.	71450.
A2 R031	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R032	RESISTOR, 91 OHM 1/4W 5% CARBON	3070910.	1121.
A2 R033	RESISTOR, 91 OHM 1/4W 5% CARBON	3070910.	1121.
A2 R034	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R035	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499.	7115.
A2 R036	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R037	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R038	RESISTOR, 5900 OHM 1/4W 1% METAL FILM	3135901.	7115.
A2 R039	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499.	7115.
A2 R040	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R042	RESISTOR, 750 OHM 1/4W 5% CARBON	3070751.	1121.
A2 R043	RESISTOR, 330 OHM 1/4W 5% CARBON	3070331.	1121.
A2 R044	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121.	1121.
A2 R045	RESISTOR, 510 OHM 1/4W 5% CARBON	3070511.	1121.
A2 R046	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121.	1121.
A2 R047	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121.	1121.
A2 R048	RESISTOR, 330 OHM 1/4W 5% CARBON	3070331.	1121.
A2 R049	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A2 R050	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A2 R051	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R052	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301.	1121.
A2 R053	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R054	RESISTOR, 5600 OHM 1/4W 5% CARBON	3070562.	1121.
A2 R055	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R056	RESISTOR, 910 OHM 1/4W 5% CARBON	3070911.	1121.
A2 R057	RESISTOR, 820K OHM 1/4W 5% CARBON	3070824.	1121.
A2 R059	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202.	1121.
A2 R060	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R061	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R062	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R063	TO		
A2 R065	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A2 R066	RESISTOR, 180 OHM 1/4W 5% CARBON	3070181.	1121.
A2 R067	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A2 R068	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R069	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R070	RESISTOR, 430 OHM 1/2W 5% CARBON	3010431.	1121.
A2 R071	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R072	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R073	RESISTOR, 270 OHM 1/4W 5% CARBON	3070271.	1121.
A2 R074	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R075	RESISTOR, 1100 OHM 1/4W 5% CARBON	3070112.	1121.
A2 R076	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A2 R077	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R078	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R079	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203.	1121.
A2 R080	RESISTOR, 20K OHM 1/4W 5% CARBON	3070203.	1121.
A2 R081	TO		
A2 R083	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A2 R084	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R085	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R086	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R087	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R088	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R089	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R090	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R091	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R092	POTENTIOMETER, 100 OHM TRIM	3110345.	71450.
A2 R093	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R094	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R095	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R096	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R097	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R098	POTENTIOMETER, 100 OHM TRIM	3110345.	71450.
A2 R099	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R100	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R101	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A2 R102	RESISTOR, 390 OHM 1/4W 5% CARBON	3070391.	1121.
A2 R103	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R104	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R105	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R106	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R107	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R108	RESISTOR, 560 OHM 1/2W 5% CARBON	3010561.	1121.
A2 R109	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R110	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R111	RESISTOR, 39.2 OHM 1/4W 1% METAL FILM	3130392.	7115.
A2 R112	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122.	1121.
A2 R113	RESISTOR, 39.2 OHM 1/4W 1% METAL FILM	3130392.	7115.
A2 R114	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R115	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A2 R116	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A2 R117	RESISTOR, 3300 OHM 1/4W 5% CARBON	3070332.	1121.
A2 R118	POTENTIOMETER, 2K OHM TRIM	3110348.	71450.
A2 R119	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R120	RESISTOR, 39.2 OHM 1/4W 1% METAL FILM	3130392.	7115.
A2 R121	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122.	1121.
A2 R122	RESISTOR, 39.2 OHM 1/4W 1% METAL FILM	3130392.	7115.
A2 R123	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R124	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R125	RESISTOR, 32.4 OHM 1/4W 1% METAL FILM	3130324.	7115.
A2 R126	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A2 R127	RESISTOR, 32.4 OHM 1/4W 1% METAL FILM	3130324.	7115.
A2 R128	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R129	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R130	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R131	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R132	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R133	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R134	RESISTOR, 32.4 OHM 1/4W 1% METAL FILM	3130324.	7115.
A2 R135	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A2 R136	RESISTOR, 32.4 OHM 1/4W 1% METAL FILM	3130324.	7115.
A2 R137	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R138	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R139	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R140	RESISTOR, 37.4 OHM 1/4W 1% METAL FILM	3130374.	7115.
A2 R141	RESISTOR, 560 OHM 1/4W 5% CARBON	3070561.	1121.
A2 R142	RESISTOR, 37.4 OHM 1/4W 1% METAL FILM	3130374.	7115.
A2 R143	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R144	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R145	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R146	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
A2 R147	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A2 R148	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R149	RESISTOR, 37.4 OHM 1/4W 1% METAL FILM	3130374.	7115.
A2 R150	RESISTOR, 560 OHM 1/4W 5% CARBON	3070561.	1121.
A2 R151	RESISTOR, 37.4 OHM 1/4W 1% METAL FILM	3130374.	7115.
A2 R152	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A2 R153	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R154	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302.	1121.
A2 R155	RESISTOR, 91 OHM 1/4W 5% CARBON	3070910.	1121.
A2 R156	POTENTIOMETER, 5K OHM TRIM	3110354.	71450.
A2 R157	RESISTOR, 2200 OHM 1/4W 5% CARBON	3070222.	1121.
A2 R158	RESISTOR, 3600 OHM 1/4W 5% CARBON	3070362.	1121.
A2 R159	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 R160	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A2 U001	IC, MC10102	1580102.	4713.
A2 U002	INTEGRATED CIRCUIT,SN74S140	1580140.	0.
A2 U003	IC, MC10102	1580102.	4713.
A2 U004	INTEGRATED CIRCUIT, MC10131P	1580131.	4713.
A2 U005	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A2 U006	INTEGRATED CIRCUIT, MC10105P	1580105.	4713.
A2 ZZZZ	SWITCH WAFER, FUNCTION	2600420.	10597.
A2 ZZZZ	SWITCH WAFER, RANGE	2600421.	10597.

PART	DESCRIPTION	EXACT NO	MFG
A3	PA & PREAMP PCB ASSY		
A3 C001	CAPACITOR, 5PF MICA	2810501.	853.
A3 C002	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C003	CAPACITOR, 3PF MICA	2810500.	853.
A3 C004	CAPACITOR, 8-50PF TRIM	2810022.	72982.
A3 C005	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 C006	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C007	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C008	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 C009	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 C010	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C011	TO		
A3 C012	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 C013	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C014	TO		
A3 C016	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C017	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C018	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C019	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C020	CAPACITOR, 0.047 UF	2830013.	0.
A3 C021	CAPACITOR, 0.047 UF	2830013.	0.
A3 C022	CAPACITOR, 5.5-18PF TRIM	2810011.	72982.
A3 C023	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C024	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A3 C025	CAPACITOR, 0.047 UF	2830013.	0.
A3 C026	CAPACITOR, 0.047 UF	2830013.	0.
A3 C027	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C028	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C029	CAPACITOR, 5000 PF DISC	2830011.	91418.
A3 C030	CAPACITOR, 5000 PF DISC	2830011.	91418.
A3 C031	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C032	CAPACITOR, 1000 PF DISC	2830000.	91418.
A3 C033	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C034	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C035	CAPACITOR, 1000 PF DISC	2830000.	91418.
A3 C036	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A3 C037	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 C038	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A3 D001	DIODE, 1N758	1520758.	1295.
A3 D002	DIODE, 1N751A	1520751.	75042.
A3 D003	DIODE, 1N756	1520756.	1295.
A3 D004	DIODE, 1N4747 20V ZENER	1524747.	0.
A3 D005	DIODE, 1N914	1520914.	7910.
A3 D006	DIODE, 1N4744 15V ZENER	1524744.	0.
A3 D007	TO		
A3 D009	DIODE, 1N914	1520914.	7910.
A3 D010	DIODE, 1N914	1520914.	7910.
A3 D011	DIODE, 1N758	1520758.	1295.
A3 D012	DIODE, 1N914	1520914.	7910.
A3 D013	DIODE, 1N758	1520758.	1295.
A3 L001	CHOKE 3 TURN BEAD	1140030.	10597.
A3 L002	CHOKE 3 TURN BEAD	1140030.	10597.
A3 L003	CHOKE 4 TURN BEAD	1140052.	10597.
A3 L004	TO		
A3 L006	CHOKE 3 TURN BEAD	1140030.	10597.
A3 L007	CHOKE 6 TURN BEAD	1140032.	10597.
A3 L008	TO		
A3 L011	CHOKE 2 TURN BEAD	1140029.	10597.
A3 Q001	TRANSISTOR, 2N5179	1565179.	4713.
A3 Q002	TRANSISTOR, 2N5179	1565179.	4713.
A3 Q003	TO		
A3 Q006	TRANSISTOR, 2N4258	1564258.	7263.
A3 Q007	TRANSISTOR, 2N5179	1565179.	4713.
A3 Q008	TRANSISTOR, 2N5179	1565179.	4713.
A3 Q009	TRANSISTOR, 2N5583	1565583.	0.
A3 Q010	TO		
A3 Q012	TRANSISTOR, 2N5943	1565943.	0.
A3 Q013	TRANSISTOR, 2N5583	1565583.	0.
A3 Q014	TRANSISTOR, 2N5583	1565583.	0.
A3 Q015	TRANSISTOR, 2N4250	1564250.	7263.
A3 Q016	TRANSISTOR, EN2484	1562484.	7263.
A3 R001	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470.	1121.
A3 R002	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A3 R003	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A3 R004	RESISTOR, 510 OHM 1/4W 5% CARBON	3070511.	1121.
A3 R005	RESISTOR, 2870 OHM 1/4W 1% METAL FILM	3132871.	7115.
A3 R006	RESISTOR, 2870 OHM 1/4W 1% METAL FILM	3132871.	7115.
A3 R007	RESISTOR, 2000 OHM 1/4W 5% CARBON	3070202.	1121.
A3 R008	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470.	1121.
A3 R009	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A3 R010	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A3 R011	POTENTIOMETER, 500 OHM TRIM	3110346.	71450.
A3 R012	RESISTOR, 27K OHM 1/4W 5% CARBON	3070273.	1121.
A3 R013	POTENTIOMETER, 20K TRIM	3110355.	0.
A3 R014	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R015	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A3 R016	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A3 R017	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047.	1121.
A3 R018	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001.	7115.
A3 R019	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A3 R020	RESISTOR, 1000 OHM 1/2W 5% CARBON	3010102.	1121.
A3 R021	RESISTOR, 121 OHM 1/4W 1% METAL FILM	3131210.	7115.
A3 R022	RESISTOR, 510 OHM 1/4W 5% CARBON	3070511.	1121.
A3 R023	TO		
A3 R025	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150.	1121.
A3 R026	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047.	1121.
A3 R027	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047.	1121.
A3 R028	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001.	7115.
A3 R029	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470.	1121.
A3 R030	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A3 R031	RESISTOR, 820 OHM 1/2W 5% CARBON	3010821.	1121.
A3 R032	RESISTOR, 820 OHM 1/2W 5% CARBON	3010821.	1121.
A3 R033	RESISTOR, 47 OHM 1/4W 5% CARBON	3070470.	1121.
A3 R034	RESISTOR, 160 OHM 1/4W 5% CARBON	3070161.	1121.
A3 R035	RESISTOR, 27K OHM 1/4W 5% CARBON	3070273.	1121.
A3 R036	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150.	1121.
A3 R037	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680.	1121.
A3 R038	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R039	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330.	1121.
A3 R040	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330.	1121.
A3 R041	RESISTOR, 51 OHM 1/2W 5% CARBON	3010510.	1121.
A3 R042	RESISTOR, 91 OHM 1/2W 5% CARBON	3010510.	1121.
A3 R043	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R044	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R045	RESISTOR, 160 OHM 1/4W 5% CARBON	3070161.	1121.
A3 R046	RESISTOR, 68 OHM 1/4W 5% CARBON	3070680.	1121.
A3 R047	RESISTOR, 15 OHM 1/4W 5% CARBON	3070150.	1121.
A3 R048	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330.	1121.
A3 R049	RESISTOR, 33 OHM 1/4W 5% CARBON	3070330.	1121.
A3 R050	RESISTOR, 51 OHM 1/2W 5% CARBON	3010510.	1121.
A3 R051	RESISTOR, 51 OHM 1/2W 5% CARBON	3010510.	1121.
A3 R052	RESISTOR, 240 OHM 1/4W 5% CARBON	3070241.	1121.
A3 R053	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R054	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R055	RESISTOR, 100 OHM 2W 5% CARBON	3050101.	1121.
A3 R056	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A3 R057	RESISTOR, 100 OHM 2W 5% CARBON	3050101.	1121.
A3 R058	RESISTOR, 240 OHM 1/4W 5% CARBON	3070241.	1121.
A3 R059	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A3 R060	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111.	7115.
A3 R061	RESISTOR,10700 OHM 1/4W 1% METAL FILM	3131072.	7115.
A3 R062	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111.	7115.
A3 R063	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392.	1121.
A3 R064	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A3 R065	TO		
A3 R067	RESISTOR, 150 OHM 1/2W 5% CARBON	3010151.	1121.
A3 R068	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A3 R069	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122.	1121.
A3 R070	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
A3 R071	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111.	7115.
A3 R072	RESISTOR,10700 OHM 1/4W 1% METAL FILM	3131072.	7115.
A3 R073	RESISTOR, 5110 OHM 1/4W 1% METAL FILM	3135111.	7115.
A3 R074	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A3 R075	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392.	1121.
A3 R076	TO		
A3 R078	RESISTOR, 150 OHM 1/2W 5% CARBON	3010151.	1121.
A3 R079	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A3 U001	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A3 U002	OPERATIONAL AMPLIFIER, UA741	1580010.	7263.
A3 ZZZZ	HEAT SINK	2000067.	13103.
A4	ATTENUATOR PCB ASSY		
A4 C001	CAPACITOR, 22PF MICA	2810530.	853.
A4 C002	CAPACITOR, 5000 PF DISC	2830011.	91418.
A4 L001	COIL ISOLATION	1140050.	10597.
A4 R001	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261.	7115.
A4 R002	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3130261.	7115.
A4 R003	RESISTOR, 34.8 OHM 1/4W 1% METAL FILM	3130348.	7115.
A4 R004	RESISTOR, 18 OHM 1/4W 5% CARBON	3070180.	1121.
A4 R005	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412.	7115.
A4 R006	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3100412.	7115.
A4 R007	RESISTOR, 10.0 OHM 1/4W 1% METAL FILM	3130100.	7115.
A4 R008	RESISTOR, 787 OHM 1/4W 1% METAL FILM	3137870.	7115.
A4 R012	RESISTOR, 110 OHM 1/4W 1% METAL FILM	3131100.	7115.
A4 R013	POTENTIOMETER, ATTENUATOR	3110353.	71450.
A4 R014	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499.	7115.
A4 R015	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499.	7115.
A4 S001	TO		
A4 S004	SWITCH, SLIDE	2600364.	10597.
A6	FRONT PANEL ASSY		
A6 J001	CONNECTOR, BNC	1310047.	91836.
A6 J002	CONNECTOR, BNC	1310047.	91836.
A6 J003	TO		
A6 J005	CONNECTOR, BNC	1310047.	91836.
A6 J006	CONNECTOR, BNC	1310047.	91836.
A6 J007	CONNECTOR, BNC	1310047.	91836.
A6 R002	POTENTIOMETER, 1K	3110342.	10597.
A6 R003	POTENTIOMETER, 10K OHM MIN	3110327.	71450.
A6 S001	SWITCH, POWER	2600407.	10597.
A6 S002	SWITCH, PUSHBUTTON	2600419.	10597.
A6 S004	FREQUENCY SWITCH ASSY	2611399.	10597.
A6 S005	SWITCH, RANGE	2600400.	10597.
A6 S006	SWITCH, MODE	2600444.	10597.
A6 S007	SWITCH, FUNCTION	2600418.	10597.
A6 S401	TO		
A6 S412	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3161000.	7115.
A7	REAR PANEL ASSY		
A7 F001	FUSE, 1-1/2 SLO BLO	1590031.	71400.
A7 J001	BINDING POST, WHITE	3550535.	10597.
A7 J002	BINDING POST, BLACK	3550536.	10597.
A7 J003	CONNECTOR, BNC	1310047.	91836.
A7 J004	CONNECTOR, BNC	1310047.	91836.
A7 Q001	TRANSISTOR, 2N4918	1564918.	4713.
A7 Q002	TRANSISTOR, 2N4921	1564921.	4713.
A7 Q003	TRANSISTOR, 2N4918	1564918.	4713.
A7 Q004	TRANSISTOR, 2N4921	1564921.	4713.
A7 S001	SWITCH, SLIDE	2600319.	10597.
A7 T001	TRANSFORMER, POWER	1200045.	10597.
A7 U001	REGULATOR THREE TERM.	1587805.	4713.
A7 U002	REGULATOR +24V MC7824	1587824.	4713.
A7 U003	REGULATOR, -24V MC7924	1587924.	4713.
A7 XF01	FUSE POST	1360103.	75915.
A7 ZZZZ	POWER CORD, 3 WIRE	1750203.	10597.
A8	START FREQUENCY LED ASSY		
A8 D001	TO		
A8 D003	LED	1520003.	0.

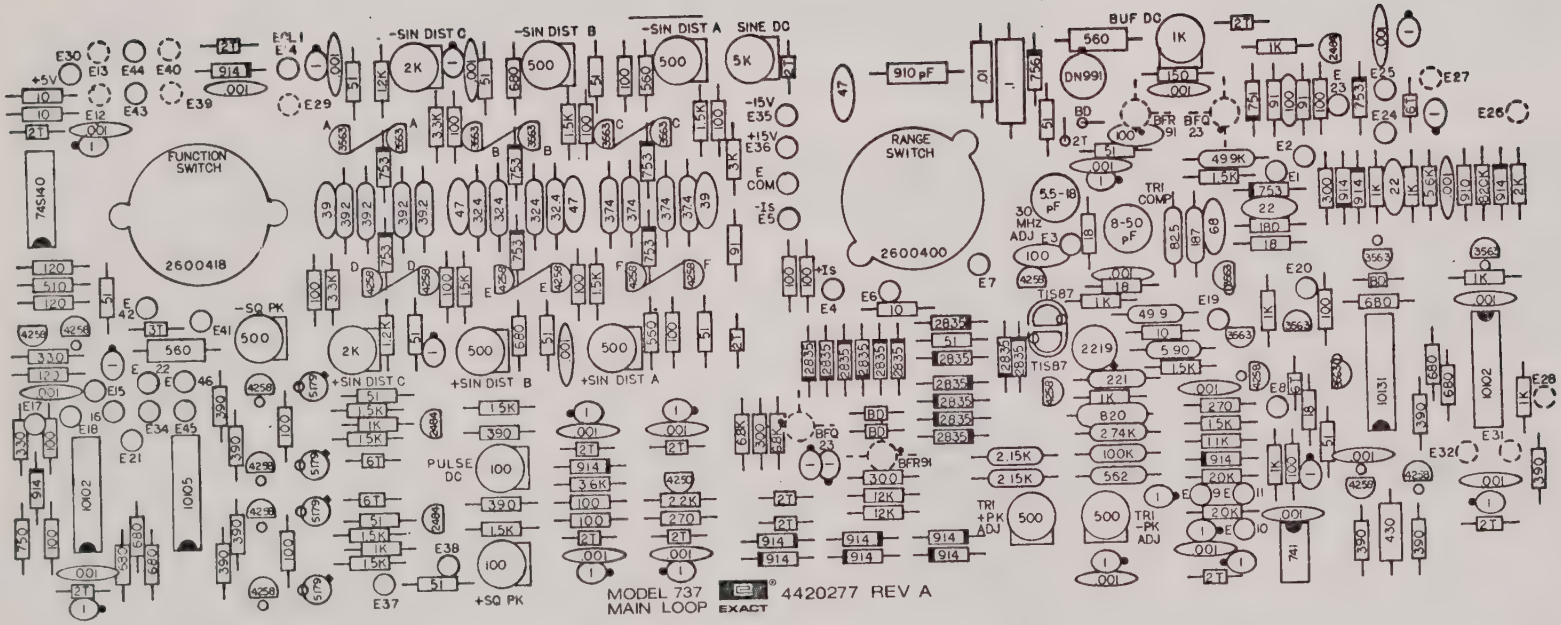
PART	DESCRIPTION	EXACT NO	MFG
A12	PULSE GENERATOR PCB ASSY		
A12C001	TO		
A12C005	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
A12C006	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A12C007	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A12C008	CAPACITOR, 10PF MICA	2810529.	853.
A12C009	CAPACITOR, 10 UF POLYSTYRENE	2900072.	0.
A12C010	CAPACITOR, 0.001 UF POLYSTYREN	2900071.	0.
A12C011	CAPACITOR, 0.01 UF POLYSTYRENE	2900070.	0.
A12C012	CAPACITOR, 0.1 UF POLYSTYRENE	2900069.	0.
A12C013	CAPACITOR,1.0 UF POLYSTYRENE	2900068.	0.
A12C014	CAPACITOR, 47PF MICA	2810532.	853.
A12C015	CAPACITOR, 39PF MICA	2810531.	853.
A12C016	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A12C017	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A12C018	CAPACITOR, 10PF MICA	2810529.	853.
A12C019	CAPACITOR, 10 UF POLYSTYRENE	2900072.	0.
A12C020	CAPACITOR, 0.001 UF POLYSTYREN	2900071.	0.
A12C021	CAPACITOR, 0.01 UF POLYSTYRENE	2900070.	0.
A12C022	CAPACITOR, 0.1 UF POLYSTYRENE	2900069.	0.
A12C023	CAPACITOR,1.0 UF POLYSTYRENE	2900068.	0.
A12C024	CAPACITOR, 47PF MICA	2810532.	853.
A12C025	CAPACITOR, 39PF MICA	2810531.	853.
A12C026	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A12C027	CAPACITOR, 5000 PF DISC	2830011.	91418.
A12C028	CAPACITOR, 5000 PF DISC	2830011.	91418.
A12C029	CAPACITOR, 0.01 UF DISC	2830005.	91418.
A12C030	CAPACITOR, 5000 PF DISC	2830011.	91418.
A12C031	CAPACITOR, 1MFD 35V	2900046.	56289.
A12C032	CAPACITOR, 100PF MICA	2810537.	853.
A12C033	CAPACITOR, 0.1 UF DISC	2830002.	56289.
A12D001	DIODE, 1N914	1520914.	7910.
A12D002	DIODE, 1N914	1520914.	7910.
A12D003	DIODE, 1N751A	1520751.	75042.
A12D004	DIODE, 1N751A	1520751.	75042.
A12L001	TO		
A12L004	CHOKE 3 TURN BEAD	1140030.	10597.
A12L005	CHOKE 2 TURN BEAD	1140029.	10597.
A12L006	CHOKE 2 TURN BEAD	1140029.	10597.
A12Q001	TO		
A12Q006	TRANSISTOR, 2N4258	1564258.	7263.
A12R001	RESISTOR, 100 OHM 2W 5% CARBON	3050101.	1121.
A12R002	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A12R003	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A12R004	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A12R005	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A12R006	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A12R007	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392.	1121.
A12R008	RESISTOR, SELECTED VALU		
A12R009	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A12R010	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
A12R011	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A12R012	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A12R013	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
A12R014	RESISTOR, 680 OHM 1/4W 5% CARSON	3070681.	1121.
A12R015	RESISTOR, 3900 OHM 1/4W 5% CARBON	3070392.	1121.
A12R016	RESISTOR, SELECTED VALU		
A12R017	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A12R018	RESISTOR, 470 OHM 1/4W 5% CARBON	3070471.	1121.
A12R019	TO		
A12R021	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A12R022	RESISTOR, 270 OHM 1/4W 5% CARBON	3070271.	1121.
A12R023	RESISTOR, 270 OHM 1/4W 5% CARBON	3070271.	1121.
A12R024	TO		
A12R026	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A12R027	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A12R028	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A12R029	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A12R030	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A12R031	RESISTOR, 560 OHM 1/2W 5% CARBON	3010561.	1121.
A12R032	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121.	1121.
A12R033	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A12R034	RESISTOR, 120 OHM 1/4W 5% CARBON	3070121.	1121.
A12R035	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A12R036	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A12R037	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A12R038	RESISTOR, 300 OHM 1/4W 5% CARBON	3070301.	1121.
A12R039	RESISTOR, 220 OHM 1/4W 5% CARBON	3070221.	1121.
A12R040	POTENTIOMETER, 50 OHM CERMET	3110362.	0.
A12R041	RESISTOR, 22 OHM 1/4W 5% CARBON	3070220.	1121.
A12R042	RESISTOR, 56 OHM 1/4W 5% CARBON	3070560.	1121.
A12R043	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
A12R044	RESISTOR, 680 OHM 1/4W 5% CARBON	3070681.	1121.
A12R045	RESISTOR, 56.2 OHM 1/4W 1% METAL FILM	3130562.	7115.
A12R046	RESISTOR, 680 OHM 1/2W 5% CARBON	3010681.	1121.
A12R047	POTENTIOMETER, 100 OHM TRIM	3110345.	71450.
A12R048	RESISTOR, 15K OHM 1/4W 5% CARBON	3070153.	1121.
A12R049	POTENTIOMETER, 20K CERMET	3110355.	0.
A12R050	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
A12S001	SWITCH, RAMP TRIG	2600384.	10597.
A12S002	SWITCH, PULSE DELAY	2600433.	10597.
A12S003	SWITCH, PULSE WIDTH	2600434.	10597.
A12U001	REGULATOR, -5V 7905	1587905.	0.
A12U002	TO		
A12U004	INTEGRATED CIRCUIT, MC10105P	1580105.	4713.
A12U005	INTEGRATED CIRCUIT, UPB10110C	1580110.	0.
A12U006	INTEGRATED CIRCUIT,SN74S140	1580140.	0.

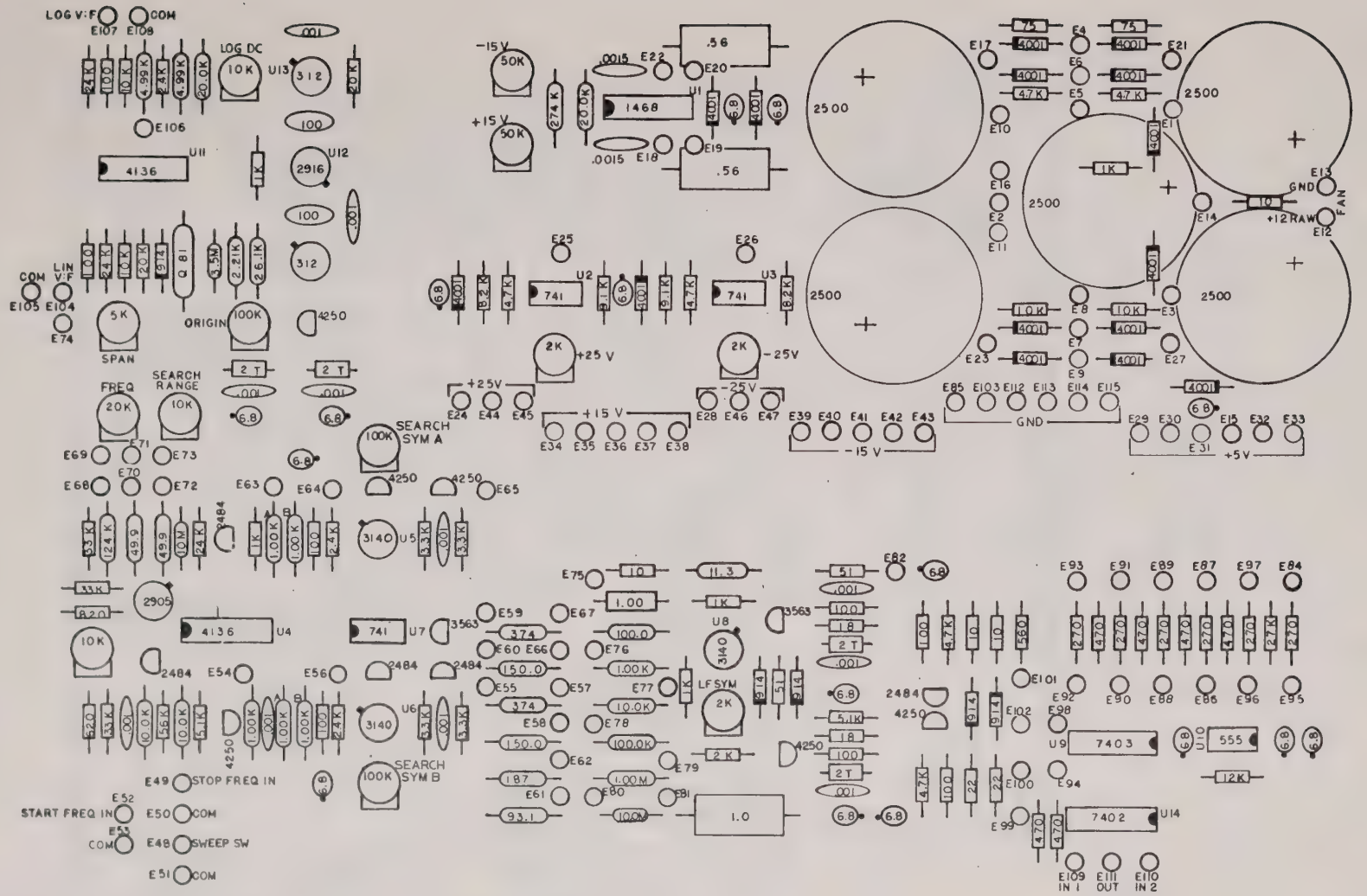
SECTION 7

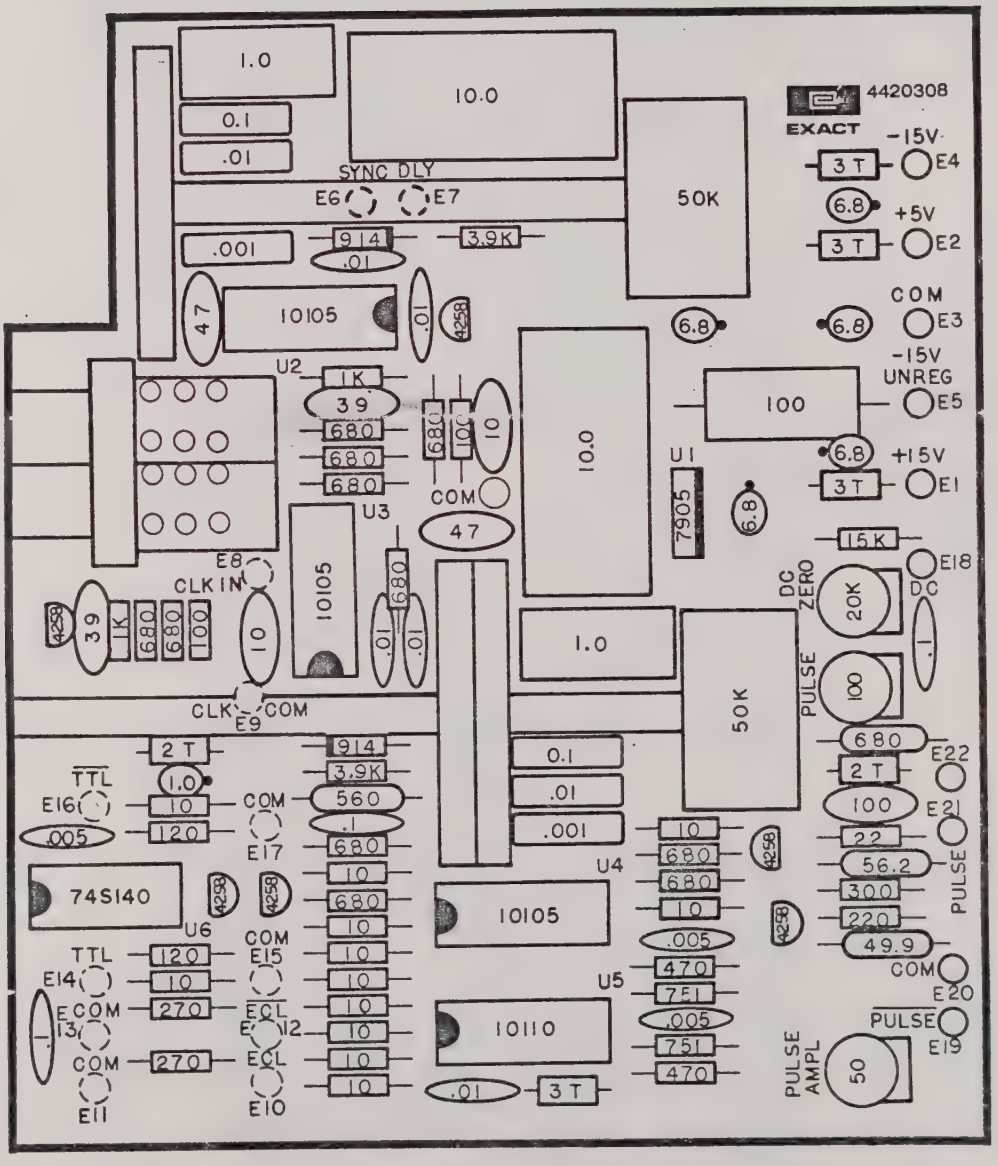
PARTS OVERLAY AND SCHEMATICS

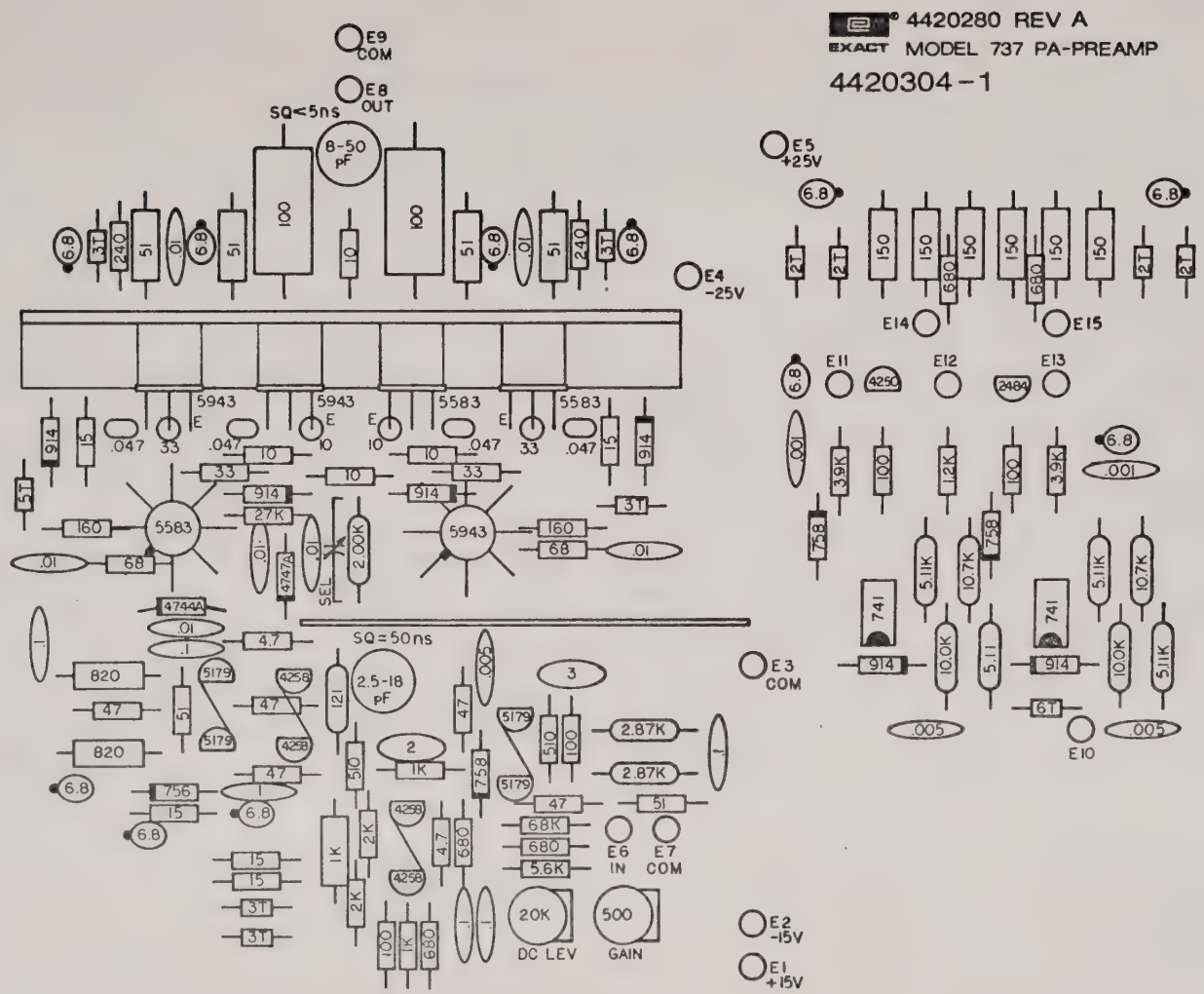
FOREWORD TO SCHEMATICS

To facilitate quick reference to inter-connections from one schematic to another, a system of numbers has been utilized. Each schematic carries its own identifying number located in a large hexagonal shape near the title. When a connection is referred to, a small hex encompasses the number of the schematic that contains the connection.

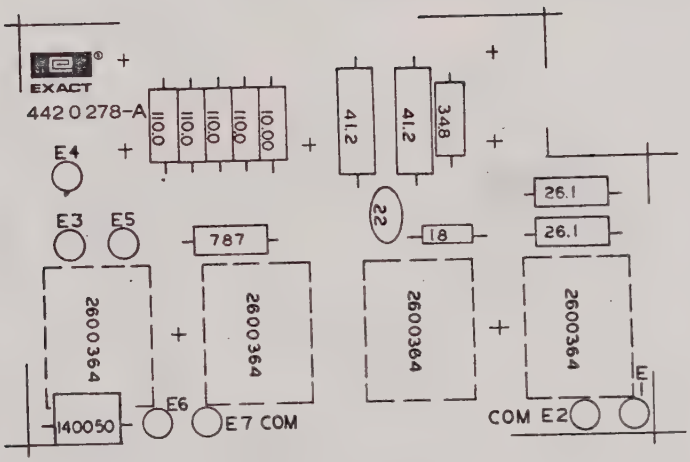

FUNCTION SWITCH
2600418
RANGE SWITCH
2600400
74S140
-SIN DIST C
-SIN DIST B
-SIN DIST A
SINE DC
BUF DC
-SQ PK
+SIN DIST C
+SIN DIST B
+SIN DIST A
PULSE DC
+SQ PK
TRI COMP
TRI +PK ADJ
TRI -PK ADJ
30 MHZ ADJ
MODEL 737
MAIN LOOP
EXACT
4420277 REV A
8000600

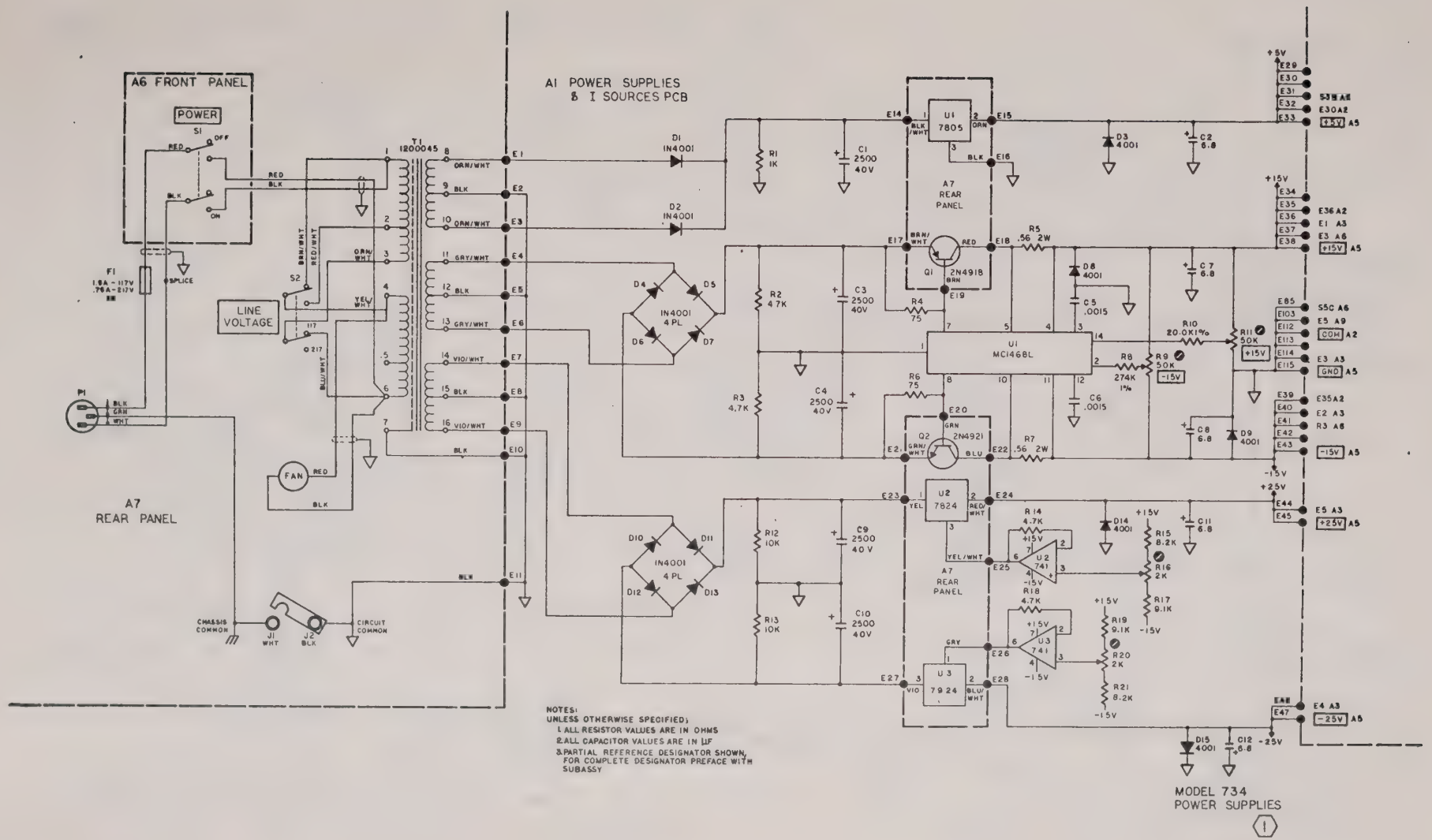

LOG V:F
COM
E107
E108
LOG DC
U13
312
E106
U11
4136
U12
2916
Q 81
ORIGIN
100K
SPAN
5K
FREQ
20K
SEARCH RANGE
10K
SEARCH SYM A
SEARCH SYM B
100K
4250
2905
U4
741
U7
3140
U5
U6
U8
LF SYM
2K
1468
U1
U2
U3
-15V
+15V
50K
+25V
-25V
.56
2500
GND
+12RAW
FAN
E13
E12
E10
E16
E2
E11
E14
E1
E17
E21
E4
E5
E6
E23
E27
E8
E7
E9
E3
E85
E103
E112
E113
E114
E115
E29
E30
E15
E32
E33
E31
+5V
E24
E44
E45
E28
E46
E47
E34
E35
E36
E37
E38
E39
E40
E41
E42
E43
E25
E26
E22
E20
E18
E19
E69
E73
E71
E70
E68
E72
E63
E64
E65
E59
E67
E60
E66
E76
E55
E57
E77
E58
E78
E62
E79
E61
E80
E81
E75
E82
E93
E91
E89
E87
E97
E84
E92
E90
E88
E86
E96
E95
E101
E102
E98
E100
E94
E99
E109
IN 1
E111
OUT
E110
IN 2
U9
7403
U10
555
7402
U14
12K
E49
STOP FREQ IN
E52
START FREQ IN
E50
COM
E53
COM
E48
SWEEP SW
E51
COM


4420308
EXACT
1.0
10.0
0.1
.01
SYNC DLY
E6
E7
50K
.001
914
.01
3.9K
47
10105
.01
4258
6.8
-15V
3 T
E4
+5V
E2
COM
E3
-15V
UNREG
E5
100
+15V
E1
U2
1K
39
680
680
680
680
100
10
10.0
U1
7905
U3
COM
47
15K
E18
DC
ZERO
20K
DC
.1
E8
CLK IN
10105
1.0
50K
PULSE
100
680
2 T
E22
E21
22
56.2
300
220
49.9
PULSE
COM
E20
PULSE
E19
CLK
E9
COM
2 T
914
3.9K
0.1
.01
.001
TTL
E16
1.0
10
120
.005
COM
560
.1
E17
680
10
680
10
10
10
10
10
10
74S140
4258
U6
COM
E15
TTL
E14
120
10
270
ECOM
13
COM
E11
ECL
E12
ECL
E10
10105
U4
10
680
680
10
.005
470
751
.005
751
470
U5
10110
.01
3 T
PULSE
AMPL
50



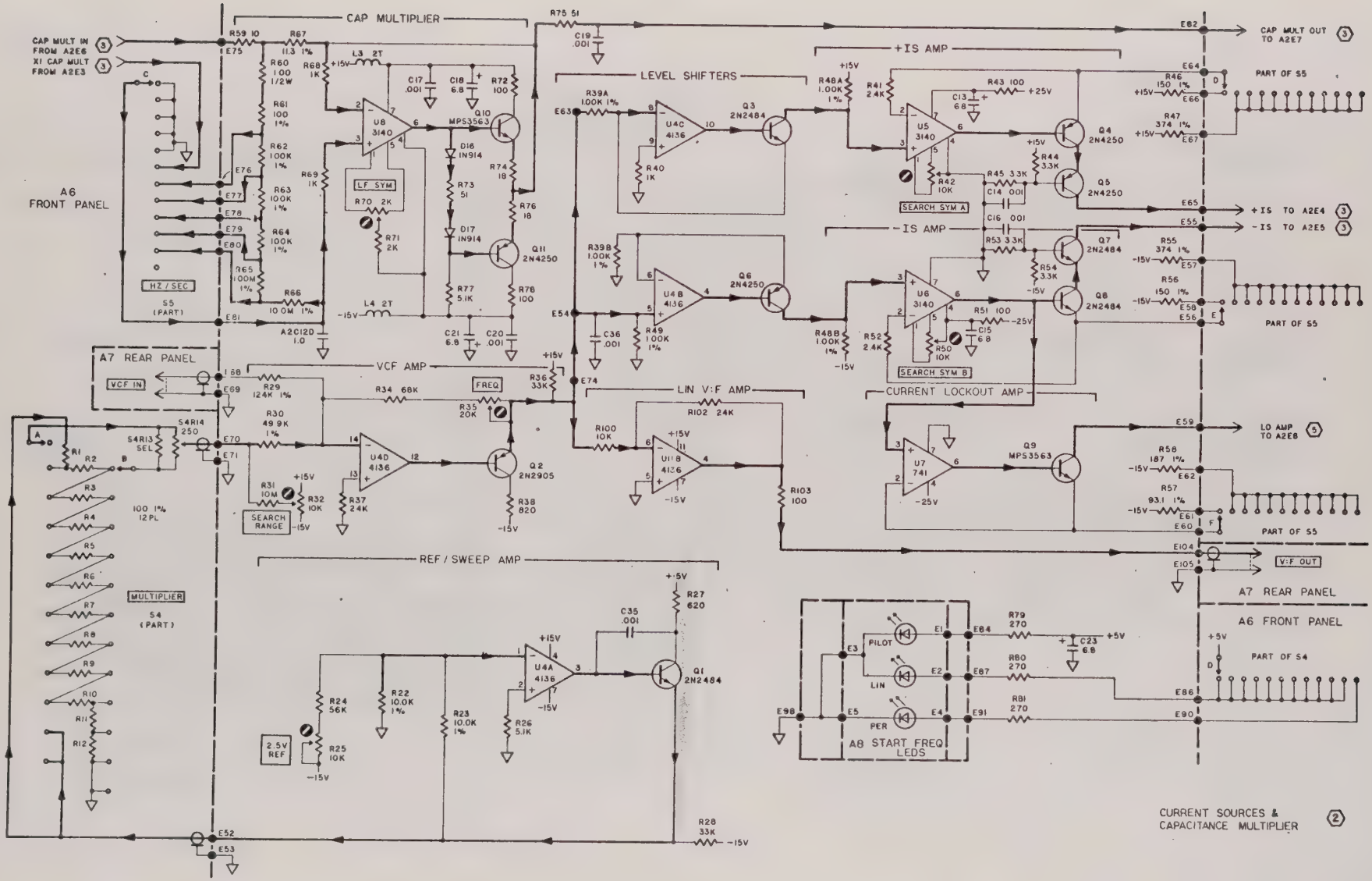
PA-PREAMP PCB

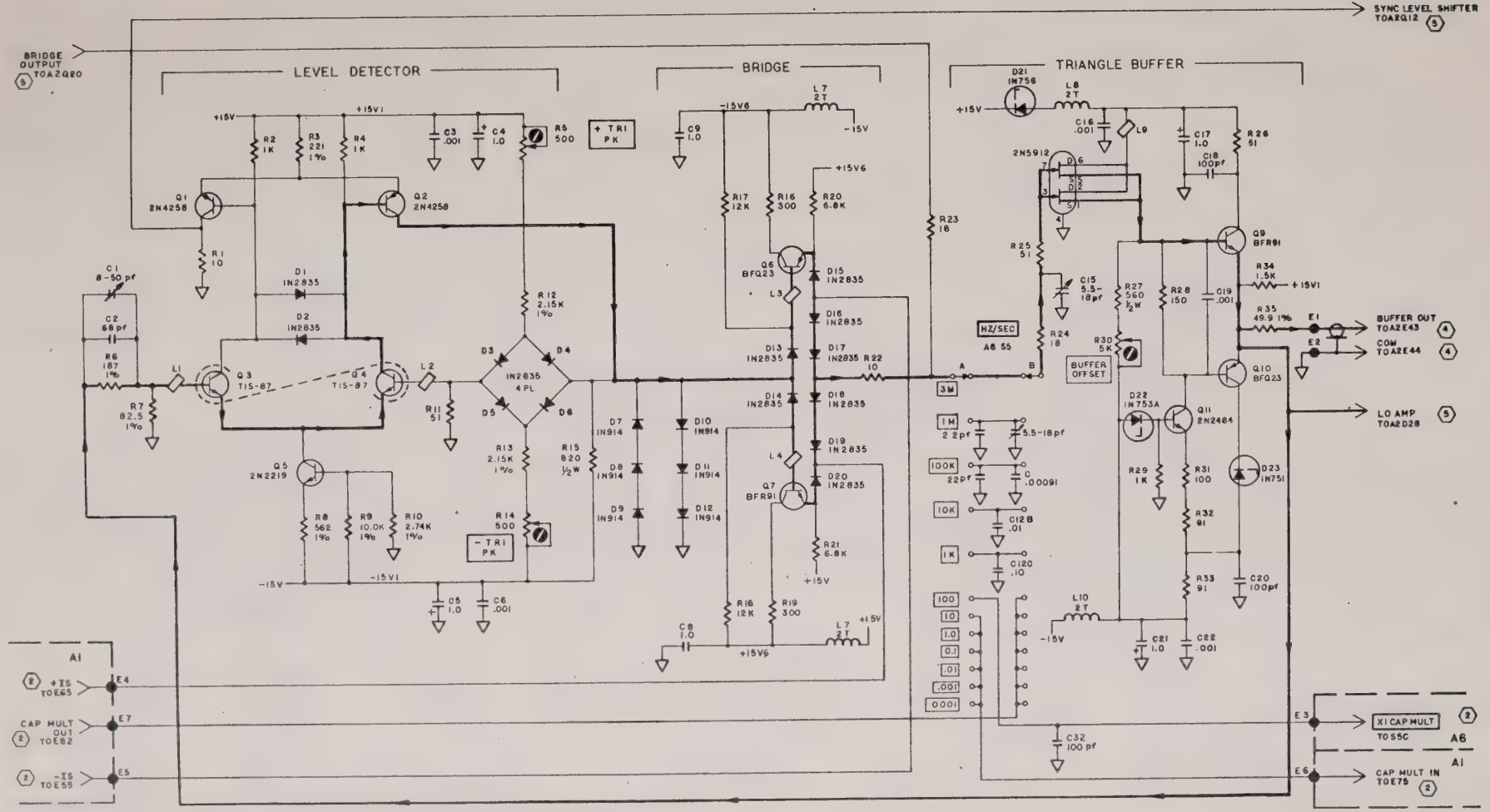

EXACT
4420278-A
110.0
110.0
110.0
10.00
41.2
41.2
348
E4
E3
E5
787
22
18
26.1
26.1
2600364
2600364
2600364
2600364
140050
E6
E7 COM
COM E2
E1

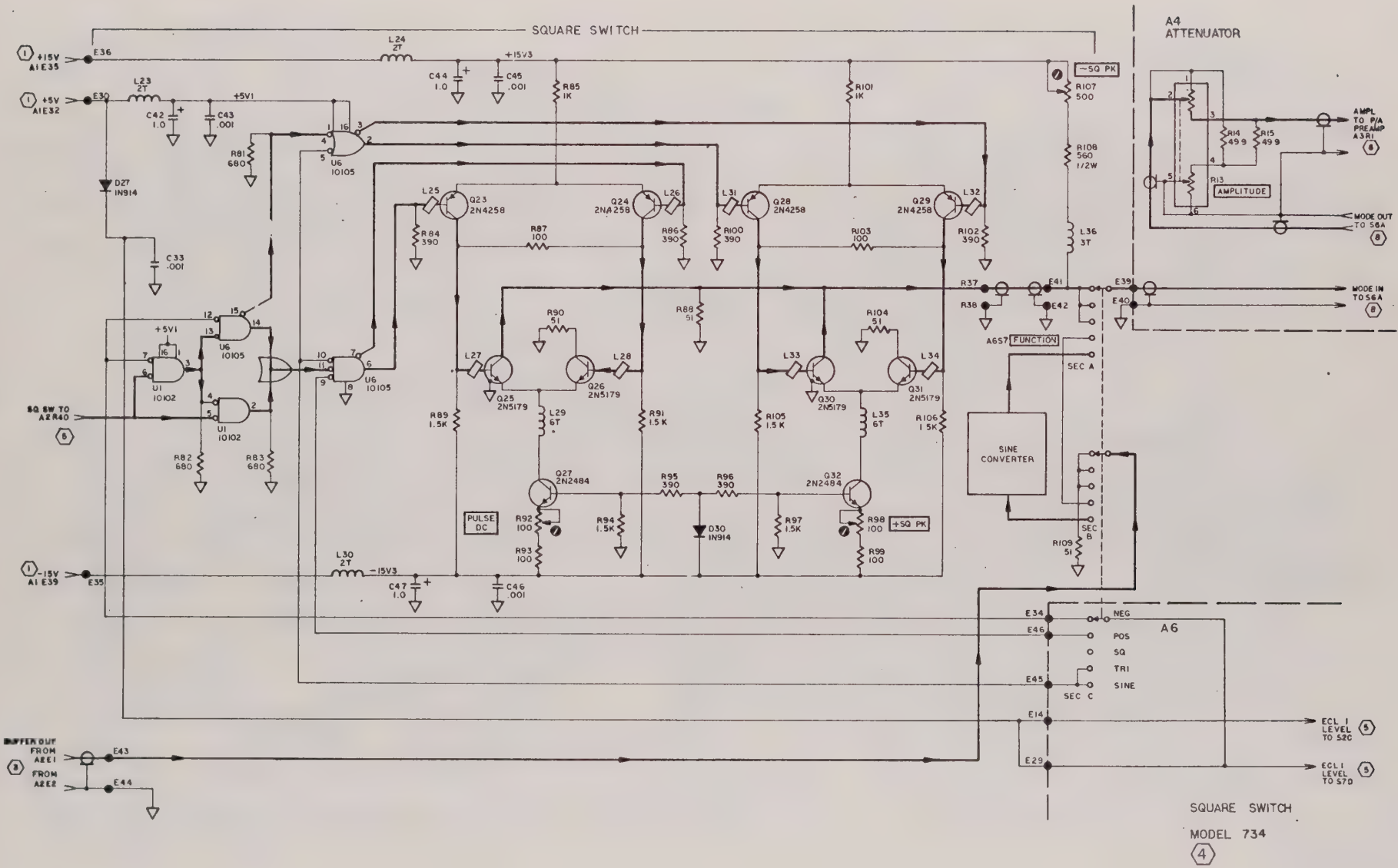


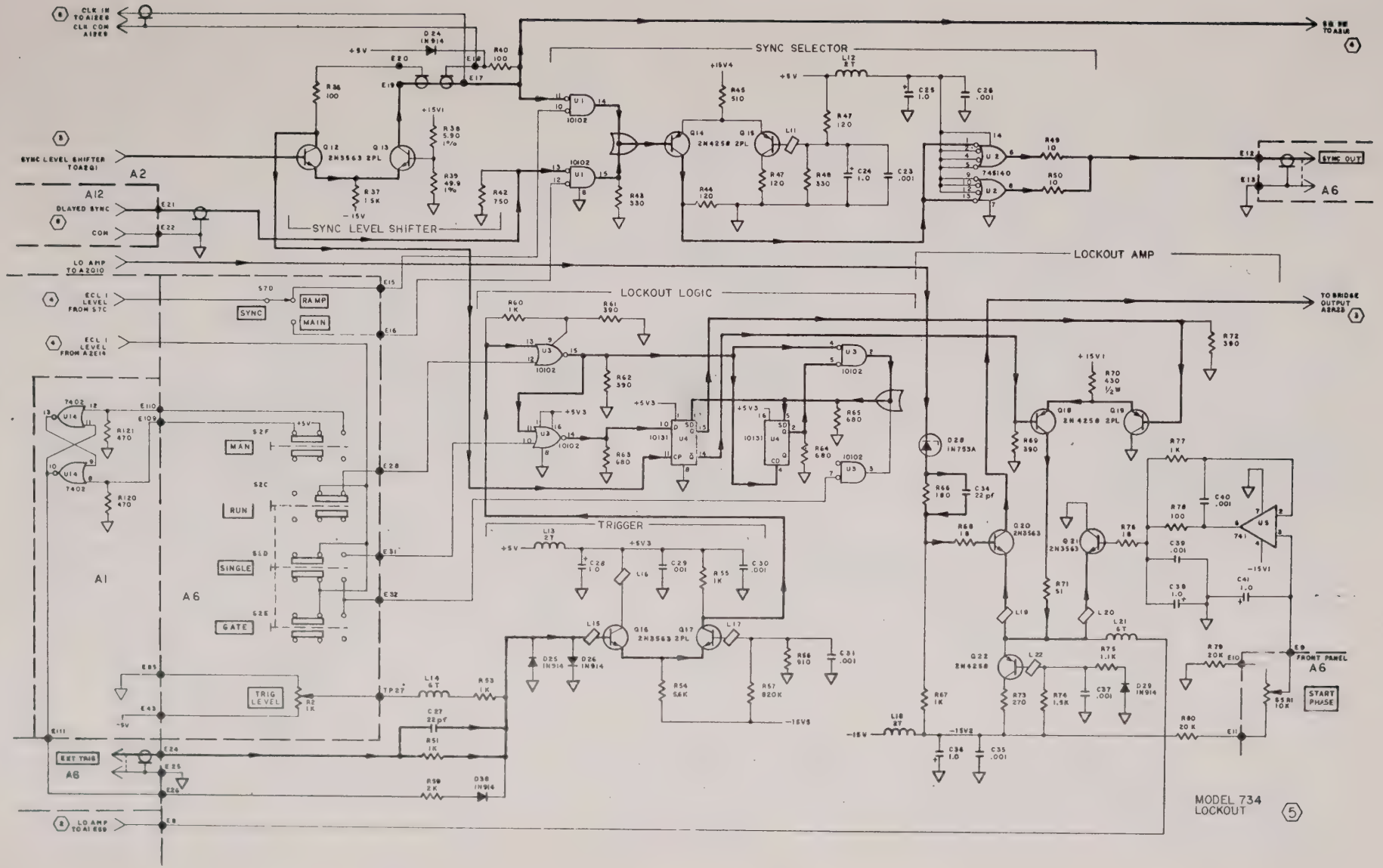
NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTOR VALUES ARE IN OHMS
2. ALL CAPACITOR VALUES ARE IN μF
3. PARTIAL REFERENCE DESIGNATOR SHOWN, FOR COMPLETE DESIGNATOR PREFACE WITH SUBASSY

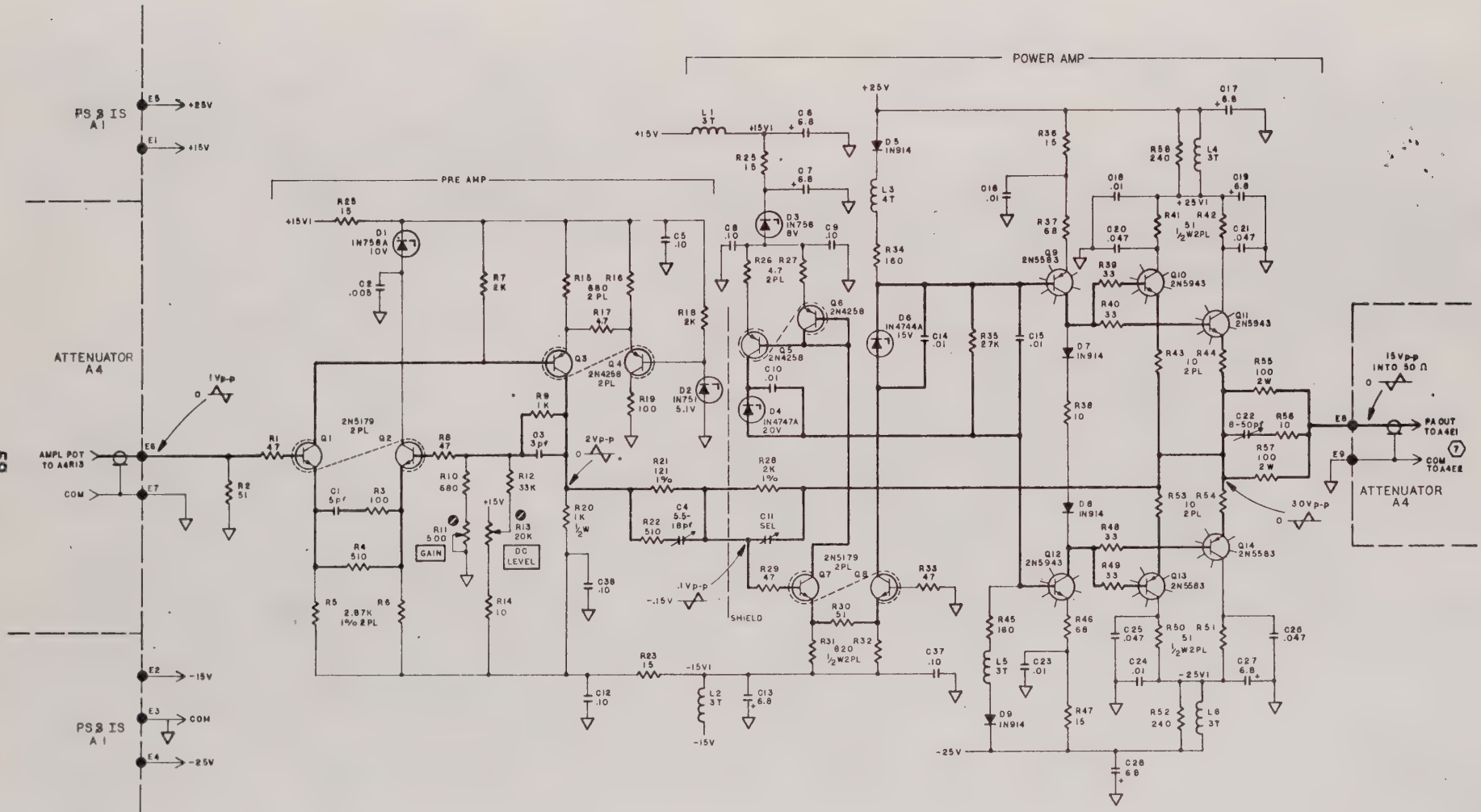
MODEL 734
POWER SUPPLIES
(1)

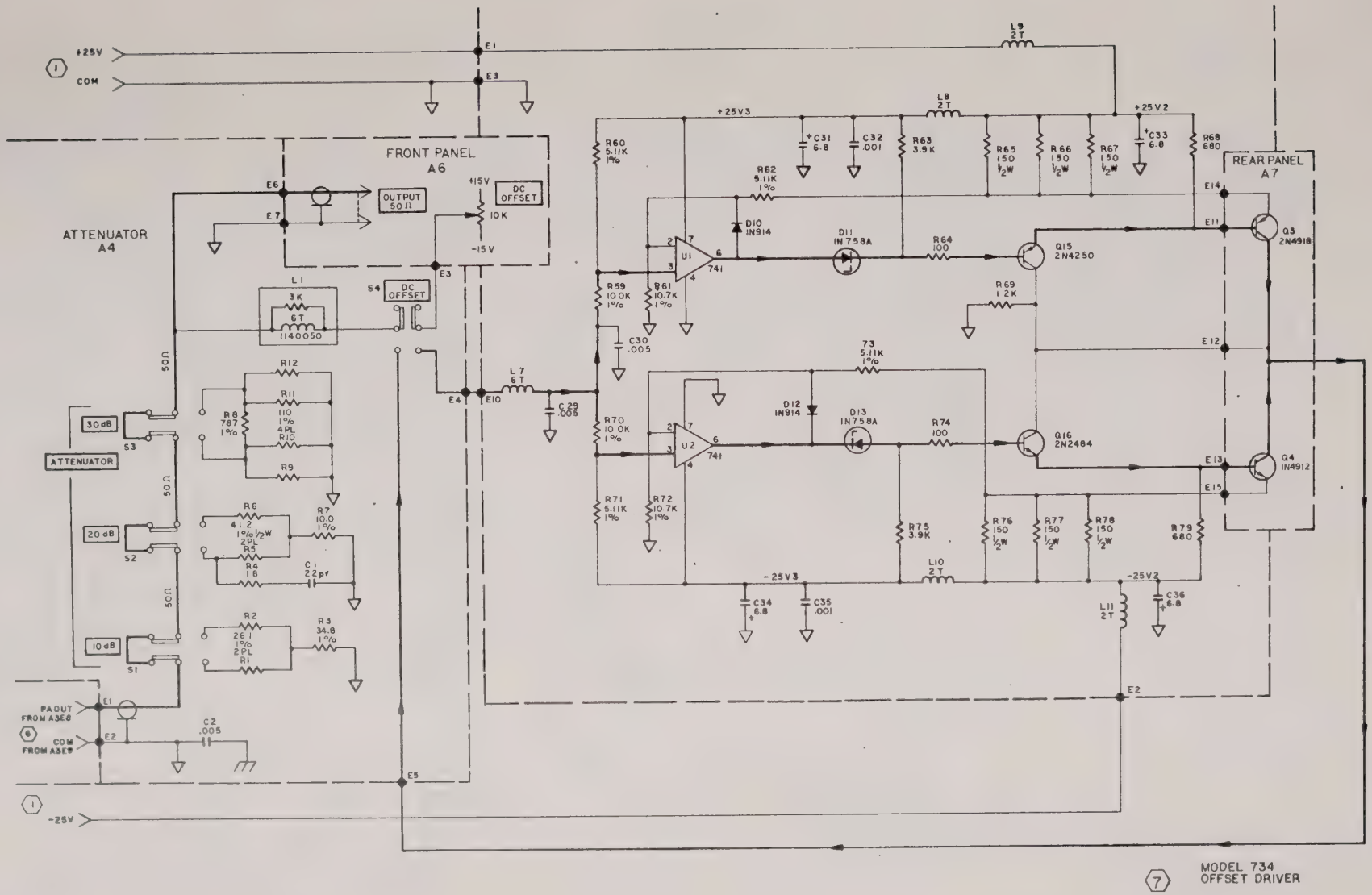

CAP MULTIPLIER
LEVEL SHIFTERS
+IS AMP
-IS AMP
VCF AMP
LIN V:F AMP
CURRENT LOCKOUT AMP
REF / SWEEP AMP
A7 REAR PANEL
A6 FRONT PANEL
MULTIPLIER
S4 (PART)
A8 START FREQ LEDS
CAP MULT IN FROM A2E6
X1 CAP MULT FROM A2E3
CAP MULT OUT TO A2E7
+IS TO A2E4
-IS TO A2E5
LO AMP TO A2E8
V:F OUT
PART OF S5
PART OF S4
SEARCH SYM A
SEARCH SYM B
SEARCH RANGE
LF SYM
HZ / SEC
2.5V REF
CURRENT SOURCES & CAPACITANCE MULTIPLIER
2

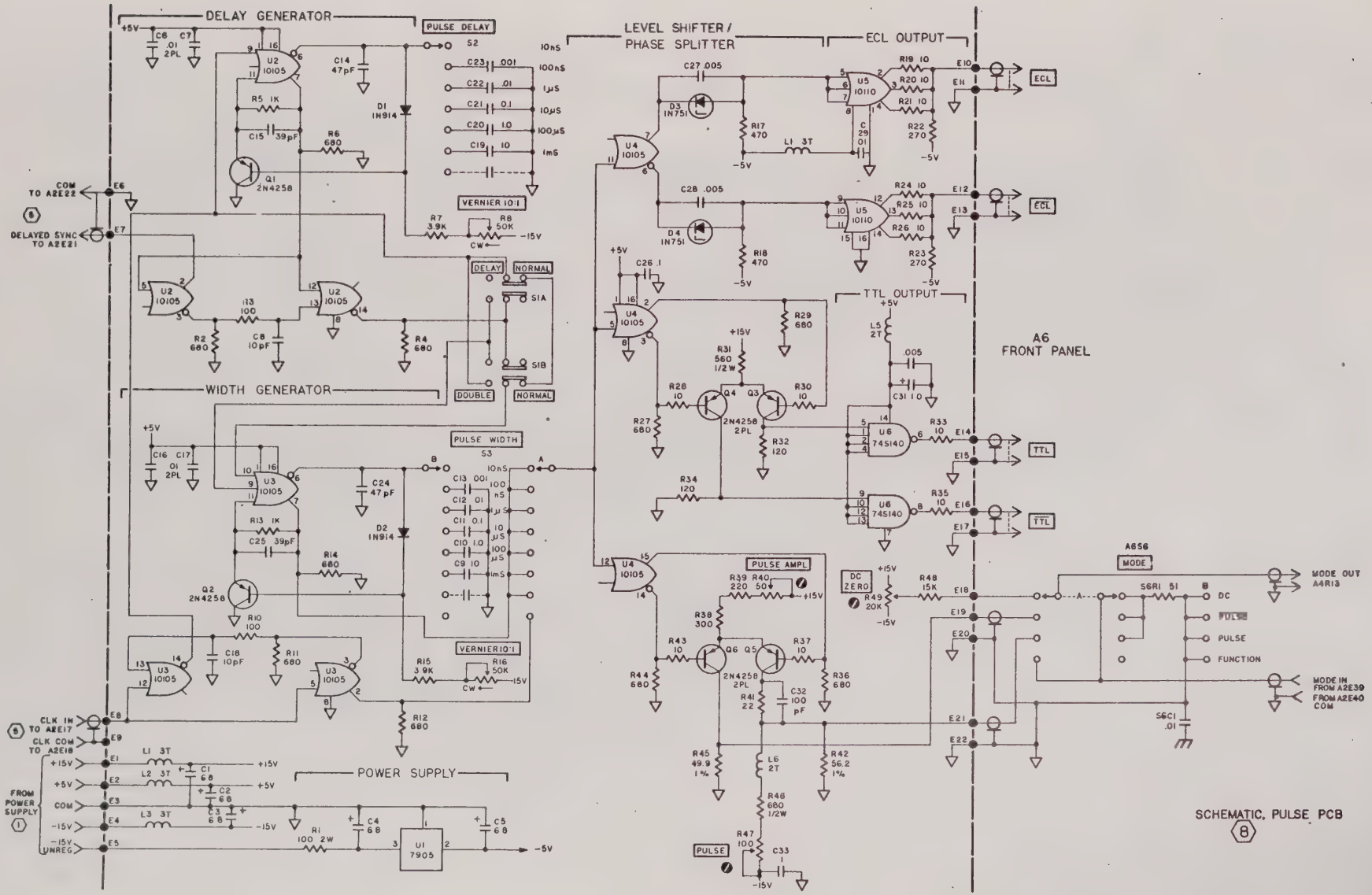

SYNC LEVEL SHIFTER TOA2Q12 5
BRIDGE OUTPUT TOA2Q80 5
LEVEL DETECTOR
BRIDGE
TRIANGLE BUFFER
+15V
-15V
+15V1
-15V1
+15V6
-15V6
Q1 2N4258
Q2 2N4258
Q3 TIS-87
Q4 TIS-87
Q5 2N2219
Q6 BFQ23
Q7 BFR91
Q9 BFR91
Q10 BFQ23
Q11 2N2484
D21 IN756
D22 IN753A
D23 IN751
2N5912
+ TRI PK
- TRI PK
HZ/SEC
A6 S5
BUFFER OFFSET
BUFFER OUT TOA2E43 4
COM TOA2E44 4
LO AMP TOA2D28 5
XI CAP MULT TO S5C 2
CAP MULT IN TOE7B 2
CAP MULT OUT TOE82 2
+IS TOE6S 2
-IS TOE5S 2
A1
A6
MODEL 734
MAIN LOOP


SQUARE SWITCH
A4 ATTENUATOR
+15V A1E35
+5V A1E32
-15V A1 E39
SQ SW TO AZR40
BUFFER OUT FROM AZE1
FROM AZE2
L24 2T
L23 2T
L30 2T
C44 1.0
C45 .001
C42 1.0
C43 .001
C33 .001
C47 1.0
C46 .001
+15V3
+5V1
-15V3
R85 1K
R101 1K
R107 500
R108 560 1/2W
L36 3T
-SQ PK
+SQ PK
R81 680
R82 680
R83 680
R84 390
R86 390
R87 100
R100 390
R103 100
R102 390
R88 51
R90 51
R104 51
R89 1.5K
R91 1.5K
R105 1.5K
R106 1.5K
R92 100
R93 100
R94 1.5K
R95 390
R96 390
R97 1.5K
R98 100
R99 100
R109 51
L25
L26
L27
L28
L29 6T
L31
L32
L33
L34
L35 6T
Q23 2N4258
Q24 2NA258
Q25 2N5179
Q26 2N5179
Q27 2N2484
Q28 2N4258
Q29 2N4258
Q30 2N5179
Q31 2N5179
Q32 2N2484
D27 IN914
D30 IN914
U6 10105
U1 10102
PULSE DC
SINE CONVERTER
A6S7 FUNCTION
SEC A
SEC B
SEC C
E36
E30
E35
E43
E44
E37
E41
E42
E39
E40
E34
E46
E45
E14
E29
NEG
POS
SQ
TRI
SINE
A6
R14 499
R15 499
R13 AMPLITUDE
AMPL TO P/A PREAMP A3R1
MODE OUT TO S6A
MODE IN TO S6A
ECL I LEVEL TO S2C
ECL I LEVEL TO S7D
SQUARE SWITCH
MODEL 734
4


SYNC SELECTOR
SYNC LEVEL SHIFTER
LOCKOUT AMP
LOCKOUT LOGIC
TRIGGER
SYNC LEVEL SHIFTER TO A2Q1
DLAYED SYNC
COM
LO AMP TO A2Q10
ECL 1 LEVEL FROM S7C
ECL 1 LEVEL FROM A2C19
SYNC OUT
A6
A2
A12
A1
SYNC
RAMP
MAIN
MAN
RUN
SINGLE
GATE
TRIG LEVEL
EXT TRIG
START PHASE
TO BRIDGE OUTPUT A8A2B
MODEL 734
LOCKOUT
5


POWER AMP
PRE AMP
PS & IS A1
ATTENUATOR A4
AMPL POT TO A4R13
COM
GAIN
DC LEVEL
SHIELD
PA OUT TO A4E1
COM TO A4E2
15Vp-p INTO 50 Ω
30Vp-p
1Vp-p
2Vp-p
.1Vp-p
+25V
+15V
-15V
-25V
OUTPUT AMP/ PREAMP
6


+25V
COM
E1
E3
L9 2T
+25V3
L8 2T
+25V2
FRONT PANEL A6
REAR PANEL A7
ATTENUATOR A4
E6
E7
OUTPUT 50Ω
+15V
DC OFFSET
10K
-15V
E3
L1 3K 6T 1140050
S4 DC OFFSET
50Ω
30dB
20dB
10dB
S3
S2
S1
ATTENUATOR
R12
R11 110 1% 4PL
R10
R9
R8 787 1%
R6 41.2 1% 1/2W 2PL
R5
R4 18
R7 10.0 1%
C1 22pf
R2 26.1 1% 2PL
R1
R3 34.8 1%
PA OUT FROM A3E8
COM FROM A3E9
E1
E2
C2 .005
E5
L7 6T
E4
E10
C29 .005
R60 5.11K 1%
R62 5.11K 1%
C31 6.8
C32 .001
R63 3.9K
R65 150 1/2W
R66 150 1/2W
R67 150 1/2W
C33 6.8
R68 680
D10 IN914
D11 IN758A
R64 100
Q15 2N4250
Q3 2N4918
U1 741
R59 10.0K 1%
R61 10.7K 1%
R69 1.2K
C30 .005
E14
E11
E12
73 5.11K 1%
D12 IN914
D13 IN758A
R74 100
Q16 2N2484
Q4 IN4912
U2 741
R70 10.0K 1%
R71 5.11K 1%
R72 10.7K 1%
E13
E15
R75 3.9K
R76 150 1/2W
R77 150 1/2W
R78 150 1/2W
R79 680
-25V3
L10 2T
-25V2
L11 2T
C34 6.8
C35 .001
C36 6.8
E2
-25V
7
MODEL 734
OFFSET DRIVER


DELAY GENERATOR
PULSE DELAY
S2
10nS
100nS
1µS
10µS
100µS
1mS
VERNIER 10:1
WIDTH GENERATOR
PULSE WIDTH
S3
POWER SUPPLY
LEVEL SHIFTER / PHASE SPLITTER
ECL OUTPUT
TTL OUTPUT
A6 FRONT PANEL
PULSE AMPL
DC ZERO
MODE
DC
PULSE
FUNCTION
SCHEMATIC, PULSE PCB
8

SECTION 8

ADDENDA

MODEL 734

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